ATTACHMENT "C"

Reproductive Success of Southwestern Willow Flycatchers in the Cliff-Gila Valley, New Mexico

Summary report for the 1998 Field Season

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INTRODUCTION

The Species. — The Southwestern Willow Flycatcher *(Empidonax traillii extimus)* is a neotropical migrant passerine that ranges from southern California and Baja California eastward through Arizona, southern Utah, southern Colorado, New Mexico, and trans-Pecos Texas (Unitt 1987). This species is an obligate riparian specialist, nesting in dense vegetation associated with watercourses. In the southwest, nesting is almost always in the vicinity of surface water or saturated soils (U.S. Fish and Wildlife Service 1995).

Populations of the southwestern willow flycatcher are thought to have declined significantly during this century, primarily due to extensive loss and conversion of riparian breeding habitats (Unitt 1987, U.S. Fish and Wildlife Service 1995). Loss and modification of riparian habitats have been attributed to many factors, including water diversion and impoundment, changes in fire and flood frequency due to hydrological alterations, livestock grazing, replacement of native riparian vegetation by nonnative species, urban development, and recreational activities (Rea 1983, Kreuper 1993, U.S. Fish and Wildlife Service 1995). Additionally, a high incidence of nest parasitism by brown-headed cowbirds (*Molothrus ater*) has been reported from several sites, resulting in low reproductive success. Cowbirds lay their eggs in the nests of other species (hosts), where cowbird chicks are raised by the host parents. For small hosts, parasitized nests rarely fledge any host young (Brittingham & Temple 1983). Nest parasitism levels of more than 50% have been documented for populations at the Kern River, California (Harris 1991) and the Grand Canyon (Brown 1994). Frequently flycatchers respond to the laying of cowbird eggs in their nests by abandoning and renesting (Whitfield & Strong 1995).

In 1993, the U.S. Fish and Wildlife Service proposed to list *E. t. extimus* as an endangered species and to designate critical habitat. In February of 1995, the USFWS listed *E. t. extimus* as endangered, although no designation of critical habitat was made (U.S. Fish and Wildlife Service 1995). The subspecies has also been listed at the state level in New Mexico, Arizona, and California (Arizona Game and Fish Department 1988, New Mexico Department of Game and Fish 1988, California Department of Fish and Game 1992).

The Cliff-Gila Valley population. — Since its listing as an endangered species, numerous surveys have been conducted across the range of the flycatcher to locate extant populations and to estimate their size. Flycatchers have been found breeding at about 109 sites throughout the southwestern United States (Marshall, in review). Approximately 78% of extant sites consist of 5 or fewer territories. The entire known breeding population in 1996 was estimated at just over 500 pairs (Marshall, in review). By far the largest known breeding concentration of Southwestern Willow Flycatchers is located in the Cliff-Gila Valley, Grant County, New Mexico. This population was estimated at 184 pairs in 1997 (Parker 1997), and at 235 pairs in 1998 (P. Boucher, personal communication; Stoleson and Finch, unpublished data). These birds are located primarily on private property owned by the Pacific Western Land Company, a subsidiary of Phelps Dodge Corporation, and managed by the U-Bar Ranch. An additional 24 pairs occur on the adjacent Gila National Forest and other private holdings. Habitat preferences of flycatchers in this population differ from those reported elsewhere (Hull and Parker 1995, Skaggs 1996, Stoleson and Finch 1997), and from populations of other subspecies.

OBJECTIVES

The goals of this study are (1) to monitor nesting success and rates of cowbird parasitism to assess the reproductive health of Willow Flycatchers in the Cliff-Gila Valley; (2) characterize and quantify the habitat preferences of this population; (3) describe and quantify the riparian bird community at the site to assess the health of the riparian habitat and to determine background rates of nest predation and cowbird parasitism among alternate cowbird host species. This report summarizes the results of the second year of the study, and presents preliminary analyses of habitat characterization.

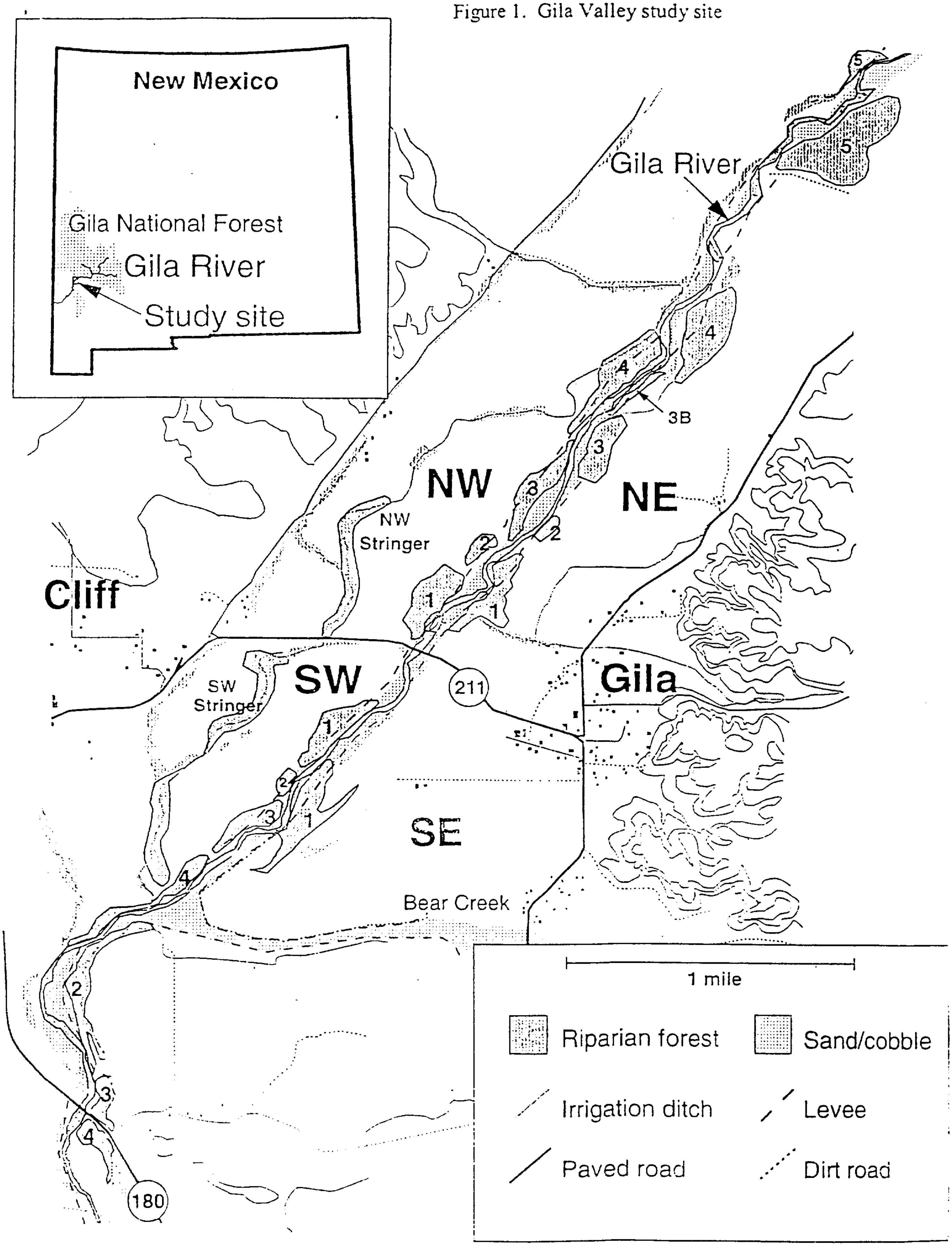
METHODS

Study area. — The Cliff-Gila Valley of Grant County, NM, comprises a broad floodplain of the Gila River, beginning near its confluence with Mogollon Creek and extending south-southwest toward the Burro Mountains. The study was primarily conducted from just below the US Route 180 bridge upstream to the north end of the U-Bar Ranch (approximately 5 km). In addition, flycatchers were studied in two disjunct sections of the valley: (1) the Fort West Ditch site of the Gila National Forest and adjacent holdings of The Nature Conservancy's Gila Riparian Preserve, located about 9 km upstream of the Route 180 bridge, and (2) the Gila Bird Area, a riparian restoration project comprising lands of the Gila National Forest and Pacific-Western Land Company, located some 8 km downstream of the Route 180 bridge. Most of the upper GilaValley consists of irrigated and non-irrigated pastures used for livestock grazing and hay farming. Elevations range from 1350 to 1420 m (Figure 1).

The Gila River floodplain contains numerous patches of Broadleafed Riparian Forest, with a canopy composed primarily of *Populus fremontii*, *Platanus wrightii*, *Salix gooddingi*, *Acer negundo*, and *Juglans major*. Most patches support an understory of shrubs, including *Rhus trilobata*, *Amorpha fruticosa*, *Salix* spp., *Baccharis glutinosa*, *Alnus oblongifolia*, *Elaeagnus angustifolia*; forbs, and grasses. Most habitat patches are less than 5 ha in area. The FS Fort West Ditch site and the Gila Bird Area are generally more open than patches on the U-Bar. In addition to the primary patches of riparian woodland along the Gila itself, numerous stringers of riparian vegetation extend along many of the earthen irrigation ditches. These stringers contain the same plant species as larger forest patches, but rarely exceed 10 m in width.

The study concentrated on three large riverine patches and two stringer patches on the U-Bar Ranch (see Figure 1: SE1, NW1, NE1, SW Stringer, and NW Stringer) and the FS Fort West Ditch site. Focal patches were chosen that had been occupied by Willow Flycatchers in previous years (Hull & Parker 1995). In addition, flycatchers were studied in other riparian patches as time allowed.

Figure 1. Gila Valley study site



Spot mapping. — Territories of all breeding land birds were determined using the spot mapping method (Robbins 1970, Bibby *et al.* 1992, Ralph *et al.* 1993). In each focal patch, a grid of 100 ft squares was established and marked with flagging tape. Grids were of varying sizes and configurations depending on the size and shape of the patch. Each plot was mapped 10 - 12 times during the season, approximately every 2-3 days. Spot mapping sessions began within 15 minutes of dawn at a different random corner of the grid each time, and lasted 2 to 5 hours (Bibby *et al.*, 1992). Weather conditions, such as cloud cover, wind speed, and precipitation were recorded on each mapping day. A new map was used for each mapping session. Following mapping, observations were transferred from the daily map to master maps for each species.

From the master maps we determined the number of breeding territories of all species for each patch. We calculated estimates of the density of breeding birds (all species) for the areas that were spot-mapped, using the following caveats. First, because the territories of large and/or wide-ranging birds (e.g., quail, raptors, crows, ravens, swallows, jays, and cuckoos) could potentially cover two or more patches and/or surrounding nonforested land, a territory was assigned to a particular patch only if the nest was located within the patch. Second, Mourning Doves (*Zenaida macroura*) breed in high densities in riparian habitats but forage mainly in open areas. Because including all doves found in a patch in calculations is likely to bias estimates of density, we followed Anderson *et al.* (1983) in using only 10% of the observed dove population.

Nest searches. — Nest searches were conducted on a daily basis following spot-mapping sessions. Within focal patches, searches were conducted for nests of all species. Only flycatcher and cuckoo nests were searched for in additional patches. Nests were monitored every 3-5 days. Nest contents were observed using pole-mounted mirrors or videocameras, or 15X spotting scopes. Nests that were abandoned or destroyed were examined for evidence (e.g., cowbird eggs, mammal hairs) to ascertain causes of nest failure. Nest predation was assumed if nest contents disappeared before fledging of young was possible (about 12 d after hatching). Nests were considered successful if they fledged one or more flycatcher young.

Habitat Measurements. — Vegetation characteristics were sampled at nest sites and at unused points using a modified BBIRD methodology (Martin *et al.* 1997). Unused points were defined as points on the spot-mapping grid that were at least 100 ft away from the nearest Willow Flycatcher nest; we based this definition on the fact that most flycatcher territories appeared to have radii much smaller than 100 ft. Within each patch, a subset of about 50-70% of potential unused points were chosen randomly for sampling.

At each unused point and nest site, a 0.02 ha plot (radius = 8 m) was placed centered on the nest tree, or on the nearest tree to the gridpoint for unused points. Standard methodology uses 0.04 ha plots, but we used smaller plots in this study to minimize problems of nonindependence of points around nests that would result from the very small territories used by flycatchers in this area. At the center of the plot and eight other points (4 and 8 m from the center in each of the four cardinal directions), we measured canopy height using clinometers, percent canopy cover using densiometers, and estimated percent ground cover. Vertical foliage density was measured at 2, 4, 6 and 8 m in each direction from the center tree by counting hits of vegetation against a 10 m vertical pole marked in 1 m increments. Within the 0.02 ha plot, trees ($\geq$ 10 cm dbh) of all species were counted and measured (dbh). Shrubs and saplings (< 10 cm dbh) were counted and measured within a 4 m radius of the center tree. For nest sites we also recorded nest plant species, nest height, and distance and direction from the trunk.

For each sample point we calculated average ground and canopy cover and average canopy height (all = mean of 9 measurements per point); foliage density index (sum of 1 m increments touched by foliage) for understory (0-3 m in height, for a maximum score of 48 per point) and mid-canopy (3-10 m in height, for a maximum score of 112 per point); the sum of shrub/sapling (<10 cm diameter) stems and tree ($\geq$ 10 cm diameter) stems by species and size class (<1cm, 1-5 cm, 5-7.5 cm, 7.5-10 cm, 10-30 cm, 30-50 cm, 50-70 cm, >70 cm). From these values we also calculated the total number of stems of willow and boxelder per point, an estimate of the total basal area of woody species per point, woody plant species richness (number of species of trees and shrubs per point), and plant species diversity (using the Shannon-Weaver Diversity Index). We calculated several variables to estimate the degree of habitat heterogeneity at points: patchiness (the diversity of foliage density among the four cardinal directions, using the Shannon-Weaver Diversity Index); and the coefficient of variation in measures of canopy cover, canopy height, and ground cover at each point.

Analyses. — We compared habitat values of unused points (n=40) to those at nest sites (n=152) using independent sample t-tests. Although we performed multiple statistical comparisons from the single set of data, we did not adjust our experiment-wise alpha level to minimize the risk of Type I errors because the modest sample sizes used for unused points are already prone to Type II errors, and we wanted to maximize our ability to detect trends.

To assess whether flycatchers used nest substrates randomly, we calculated an index of availability for each nest tree species to compare usage with availability. Because flycatcher nests were found in vegetation of all size classes 1 cm DBH and greater, we pooled all size classes > 1 cm DBH as potential nest substrates. A total stem count for each species was calculated from all nest sites. The relative availability of a particular plant species *x* was calculated as: total number of stems for species *x* / total number of all stems. The numbers of used versus unused stems were compared using chi-square analyses.

RESULTS

WILLOW FLYCATCHERS

Willow Flycatcher nest substrates. — We found a total of 130 willow flycatcher nests on the U-Bar ranch in 1998. An additional 35 nests were found on nearby Forest Service and Nature Conservancy lands. In the combined data set of all 257 nests found in 1997-1998, the majority of nests (76.7%) were located in boxelder (Fig. 2). In 1998, nests were found in several

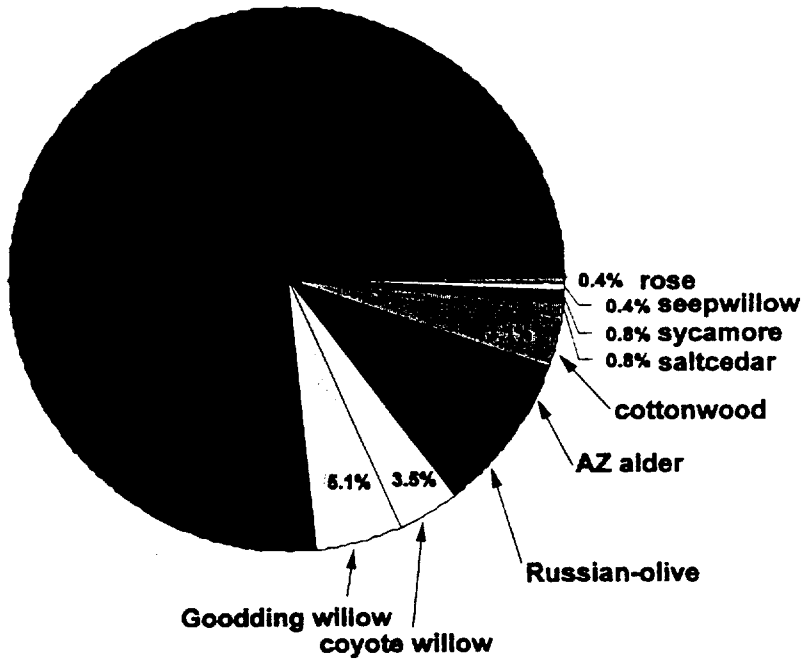


Figure 2. Nesting substrates of 257 nests of the Southwestern Willow Flycatcher in the Cliff-Gila Valley, 1997-98.

substrates not encountered previously in the Cliff-Gila Valley, including Fremont cottonwood, Arizona sycamore, seepwillow, and a nonnative climbing rose (*Rosa multiflora*). The sycamore nests represent the first recorded nests in this substrate anywhere in the Southwest (Stoleson and Finch in press). Nests in cottonwood and seepwillow were located in early successional riparian patches on FS and TNC properties. Boxelder was even more dominant (85%) as a substrate among the 213 nests found in the more mature woodlands found on the U-Bar Ranch.

Substrate use versus availability. — Plant species were not used for nesting in proportion to their availability within flycatcher territories. Boxelder and Russian olive were used significantly more than would be expected if birds chose nest trees randomly (Likelihood Ratio test G=271.8 and 5.2, P<0.001 and P=0.023, respectively). Boxelders comprised less than 35% of woody stems, yet contained more than 75% of all the nests found (Fig. 3). In contrast, willows were used less than expected by chance (G=60.6, P<0.001). The two willow species made up more than 40% of woody stems within flycatcher territories, but only 8.6% of nests were placed in either willow species. These results indicate an active preference by flycatchers for boxelder and Russian olive, and active avoidance of willow, as a nest substrate.

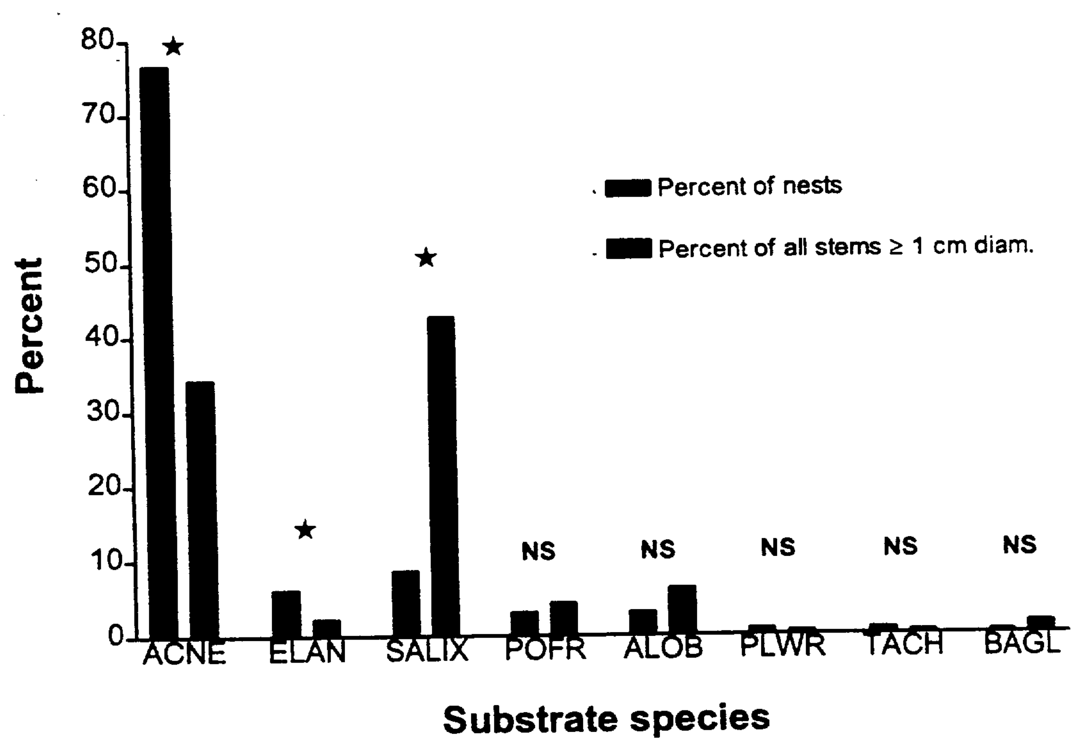


Figure 3. Use versus availability of nest substrates by Willow Flycatchers in the Cliff-Gila Valley, 1997-98. Significant ($P<0.05$) overutilization is indicated by red stars, underutilization by black stars, NS = not significant. ACNE = boxelder, ELAN = Russian olive, SALIX = willow species, POFR = cottonwood, ALOB = Arizona alder, PLWR = Arizona sycamore, TACH = salt cedar, and BAGL = seepwillow.

Nest heights. — Flycatcher nests ranged from 1.2 to 18.5 m in height. The mean height of all nests found in 1997-98 was 7.4 ± 3.8 m, with a median height of 6.8 m (Fig. 4). Average nest heights varied among different nest substrates (Fig. 5). Boxelder nests were significantly higher (8.3 ± 3.7 m) than nests in all other substrates combined (4.6 ± 2.6 m; t = -8.57, df = 138.9, P<0.001). Nests also tended to be higher than average in sycamore.

Willow Flycatcher nest success. — Of 103 nests of known outcome found on the U-Bar in 1998, 45 (42.7%) successfully fledged one or more flycatcher young. The outcome of 27 nests was uncertain. Of 34 nests of known outcome found on lands other than the U-Bar Ranch, 14 (41.2%) were successful. Of the failed nests on the U-Bar, fourteen appeared to have been deserted during or immediately after building, but before any eggs were laid in them. The cause

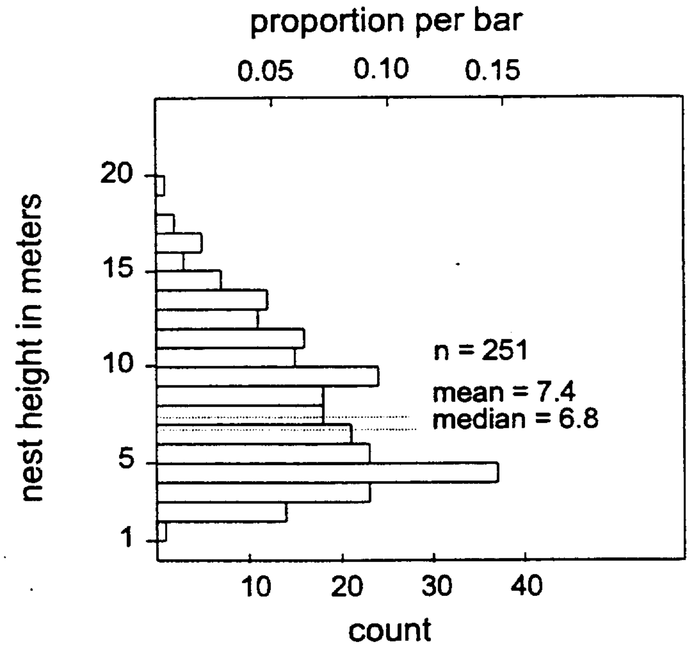


Figure 4. Distribution of heights of Willow Flycatcher nests in the Cliff-Gila Valley, 1997-98.

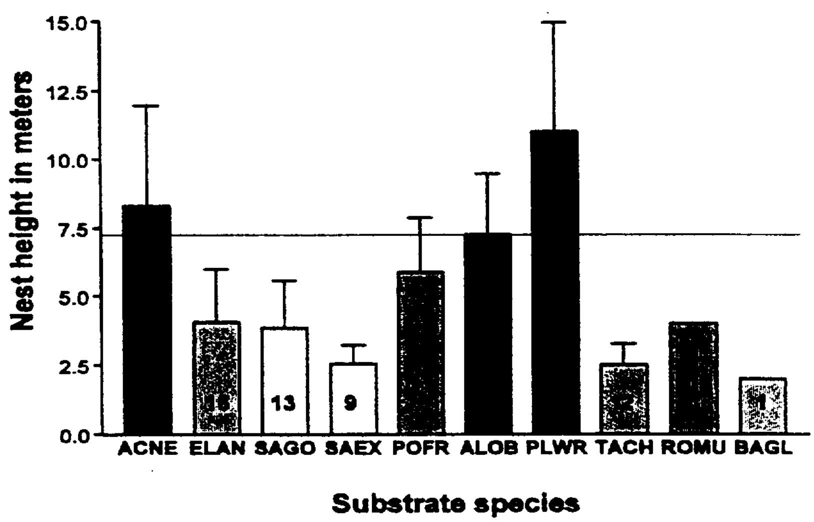


Figure 5. Heights (mean + SD) of 251 Willow Flycatcher nests in different nest substrates. Horizontal line indicates the overall mean, and numbers in bars are samples sizes. ROMU=multiflora rose, other substrate acronyms as in Figure 3.

of this high rate of desertion is unclear, but may have been related to (1) the repeated presence of humans in the vicinity of nests, (2) a high incidence of cowbirds near nests, or (3) damage from high winds. The first suggested cause is unlikely, as nests were visited at a similar rate in 1997, when only one instance of desertion was noted. The second suggestion may be possible, as a higher rate of cowbird parasitism was recorded in 1998 than in 1997 (see below). Alternatively, winds may have been responsible as we recorded numerous nests of other species being either deserted or blown out of trees entirely, including species such as the Western Wood-Pewee which is rarely parasitized by cowbirds. If deserted nests are discounted, then the nest success rate on the U-Bar was 45% in 1998.

The overall nest success rate for all nests (including those abandoned) from 1997-98 was 46.6%. The likelihood of a nest being successful varied among nest substrates (Fig. 6). Nests in Goodding's willow and Russian olive were less likely to be successful than average, while nests in boxelder, coyote willow, alder, and cottonwood were more likely to be successful than average. For the remaining plant species, sample sizes are too small to make any generalizations. The likelihood of a nest being successful showed a strong correlation with nest height: the higher the nest, the more likely it was to be successful (Fig. 7). This correlation and the fact that nests tended to be placed at different heights in different substrates may explain the differential nest success among substrates.

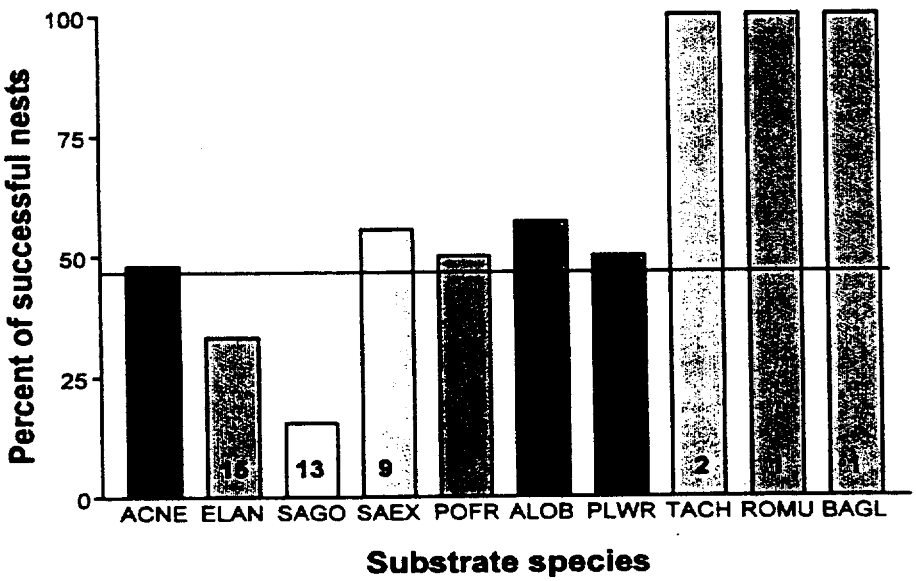


Figure 6. Nesting success as a function of nest substrate. Horizontal line indicates overall mean success rate, and substrate acronyms as in Figure 5.

A total of 74 nests of known outcome from 1997 and 1998 were located in patches that were open to cattle for at least part of the year (SW Stringer, NW Stringer, NW4, SW1, SW2, SW3, SW4, and the south end of SE1). Of these, 37 (50.0%) were successful. On the U-Bar, 88 nests of known outcome were located in patches excluded from cattle. Of these, 40 (45.5%) were successful. We found no significant effect of grazing on nesting success (G=0.33, P=0.56). Nest parasitism rates in the grazed patches (17.4%) did not differ significantly from the parasitism rate in excluded patches (21.8%; G=0.31, P=0.58). All patches at the site were within 1 km of grazed pastures for at least part of the breeding season.

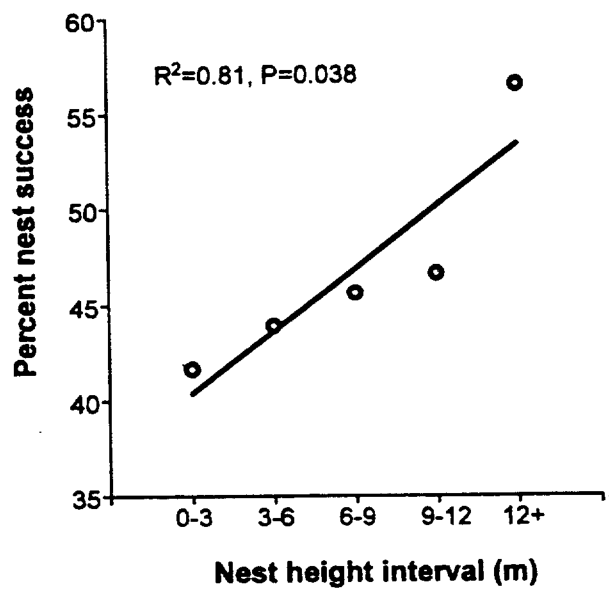


Figure 7. Correlation of nest height interval and average nesting success rate for each interval.

Causes of nest failure. — A total of 110 flycatcher nests were known to have failed during 1997-1998. Of these, the cause was not determinable for 24 (21.8%). More nests were lost to predators than to any other cause (Fig. 8). Other than one nest lost to a Great Horned Owl (*Bubo virginianus*) in 1997, we did not witness any failures due to predation, so the identity of nest predators can only be speculative. However, nests of other bird species were observed being depredated by Common Ravens (*Corvus corax*), Western Scrub-Jays (*Aphelocoma californica*), and a rock squirrel (*Spermophilus variegatus*). Desertion (defined here as nest abandonment prior to egg-laying) was the next most frequent cause of nest failure, followed by abandonment (after the onset of laying). Thirteen nests were known to have failed due to cowbird parasitism.

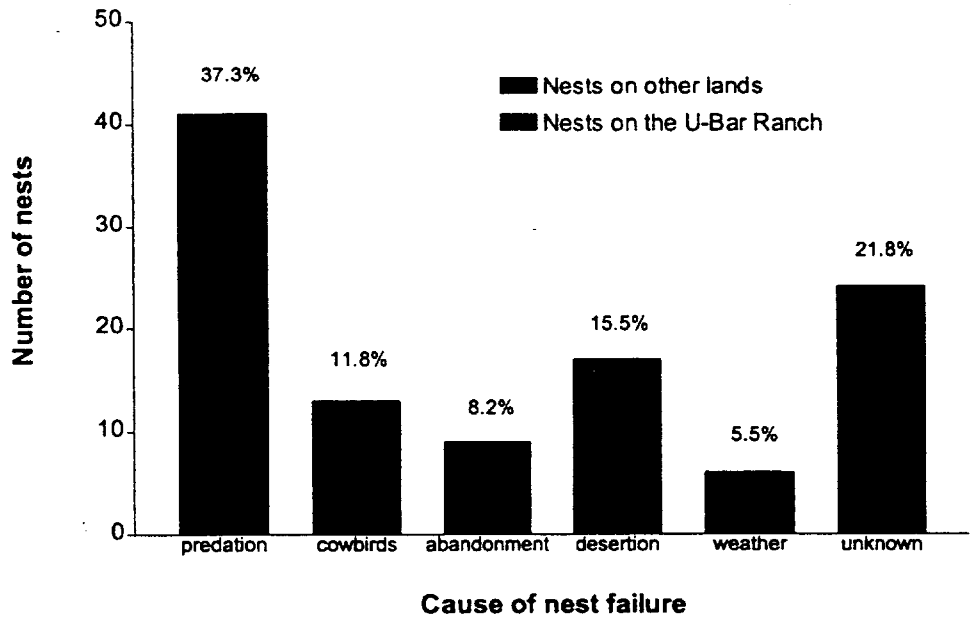


Figure 8. Causes of nest failure for 110 Willow Flycatcher nests in the Cliff-Gila Valley, 1997-98. Desertion = abandonment of nest prior to egg-laying, abandonment = after the first egg is laid.

Cowbird parasitism. — A total of 28 out of 129 nests (27.1%) of known status were parasitized by cowbirds in the Cliff-Gila Valley in 1997-1998. Observed parasitism rates were higher in 1998 than in 1997 (Fig. 9). In both years, nests on the U-Bar were somewhat less likely to be parasitized by cowbirds than nests on other lands, though this trend was not statistically significant ($G<0.95$, $P>0.25$).

The probability of a nest being parasitized by cowbirds was not significantly correlated with nest height ($P=0.65$), although there was a nonsignificant trend for nest parasitism to decrease with increasing nest height (Fig. 10). These data may be suspect because of the difficulties in determining whether high nests were parasitized or not.

The likelihood of a nest being parasitized varied among nest substrates. About 14% of the boxelder nests were parasitized, while nests in willow, Russian olive, and cottonwood were much more likely to be parasitized (Fig. 11). Other substrates were too infrequently used to make any generalizations.

The proportion of parasitized nests varied among the six focal patches. Surprisingly, there was a strong and almost statistically significant *negative* correlation between patch-wise parasitism rates and the estimated density of female cowbirds in a patch (Fig. 12). That is, the higher the estimated density of cowbirds within a patch, the *lower* the proportion of flycatcher nests in the patch that were parasitized.

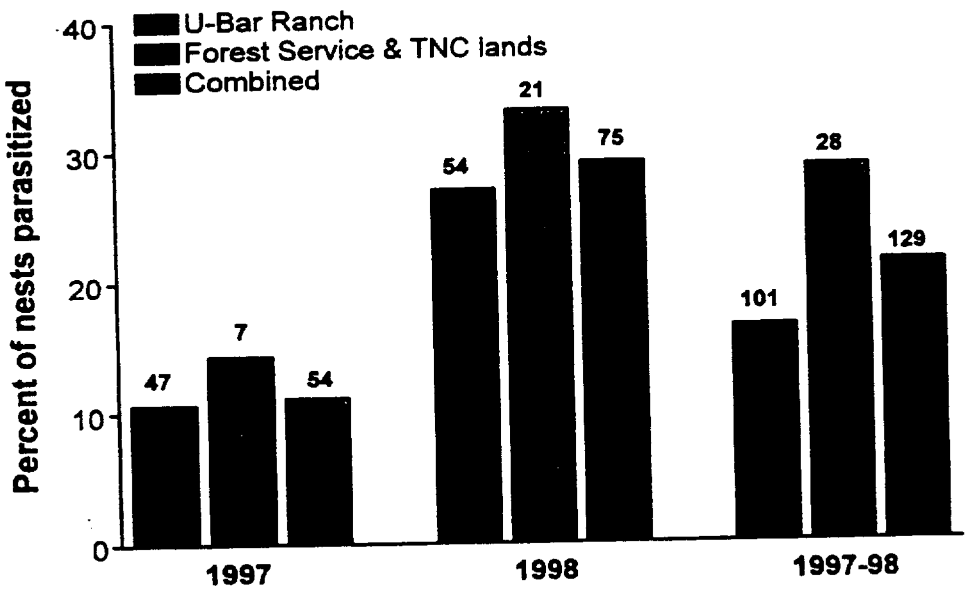


Figure 9. Rates of cowbird parasitism on Willow Flycatcher nests as a function of year and land ownership. Numbers above bars are sample sizes of all nests known to parasitized or not.

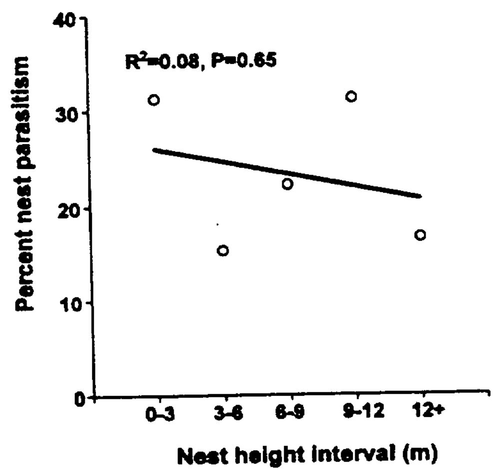


Figure 10. Correlation of nest height interval and average nest parasitism rate for each interval.

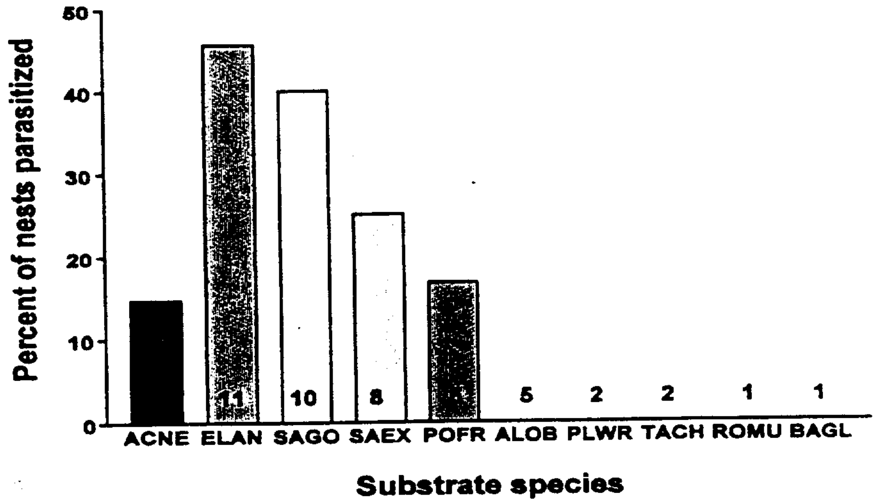


Figure 11. Average rate of nest parasitism as a function of nest substrate; acronyms as in Figure 5.

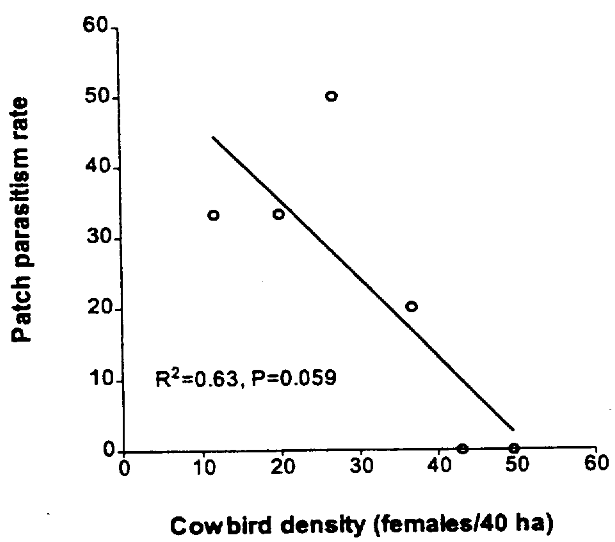


Figure 12. Correlation between average density of cowbirds per patch and patch parasitism rate.

Of the 28 flycatcher nests known to have been parasitized in 1997 and 1998, nine (32%) were abandoned immediately by the flycatchers (Fig. 13). Of those nests where cowbird eggs were accepted, most were depredated. Five nests fledged a single cowbird chick, and two fledged just flycatcher young despite having been parasitized. One nest was known to have fledged two flycatcher young in addition to a cowbird chick. The parents at this nest were seen to preferentially feed their own nestlings after the cowbird had fledged; it is unknown whether the cowbird fledgling survived. We were unable to determine the outcome of two parasitized nests in which both cowbird and flycatcher young had hatched.

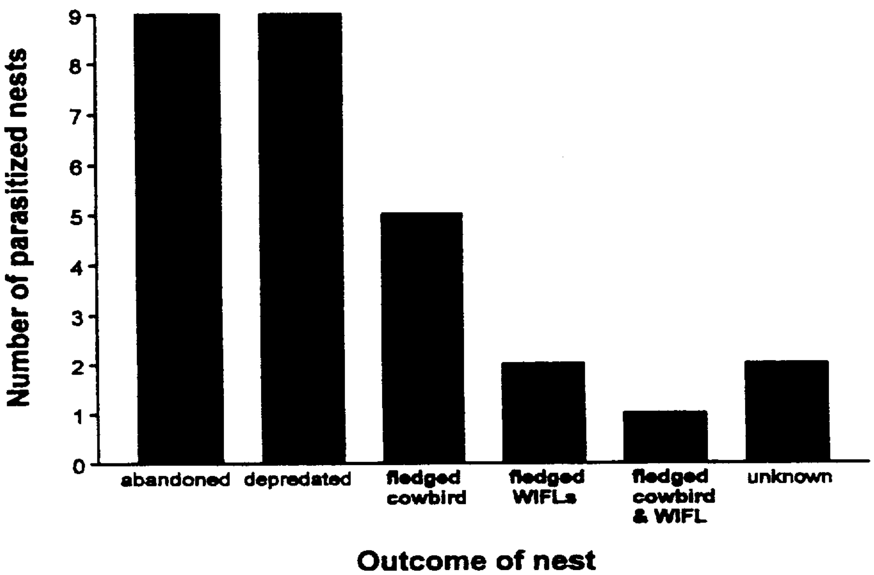


Figure 13. Fate of 28 Willow Flycatcher nests parasitized by cowbirds 1997-1998.

Willow Flycatcher nest site characteristics. — The habitat around Willow Flycatcher nests typically exhibits moderate ground cover, but high canopy cover and foliage density (Table 1). Canopy heights are moderate for the valley, averaging less than 15 m. Thus, flycatcher areas do not usually include the tall cottonwood galleries with canopies in excess of 25 m. Nor do they generally include the low, young growth of coyote willow and seepwillow. Flycatcher habitat also typically has a well-developed understory, as indicated by the high average stem count for shrubs (Table 1).

Flycatcher nesting habitat on the U-Bar Ranch, which was primarily in older, mature riparian woodland, differed significantly in some respects from nesting habitat elsewhere in the Cliff-Gila Valley. Specifically, the habitat on the U-Bar had, on average, a higher canopy, higher foliage density above 3 meters, fewer stems of shrubs or trees, more boxelders, fewer willows, and fewer woody plant species than did habitat elsewhere (Table 1). These differences emphasize the fact that much of the rest of the valley supports habitat that is younger, early-successional woodland and thickets, characterized by more shrub stems and species.

Table 1. Habitat characteristics (mean ± SD) at Willow Flycatcher nest sites on the U-Bar Ranch and elsewhere in the Cliff-Gila Valley, New Mexico, 1997-1998. Sample sizes are 136 nests (U-Bar) and 25 nests (other). Significant differences (*P*<0.05, based on independent-samples t-tests) are indicated in bold face. See Methods for definitions of variables.

Variable	U-Bar nests	Other nests	*P* value
Average ground cover (%)	32.4 ± 23.3	34.1 ± 33.5	0.83
Average canopy cover (%)	84.1 ± 11.2	85.6 ± 15.4	0.69
Average canopy height (m)	13.4 ± 4.8	10.2 ± 4.8	**0.009**
Foliage density @ 0-3 m	12.0 ± 6.6	12.9 ± 6.4	0.53
Foliage density @ 3-10 m	42.9 ± 13.0	35.8 ± 11.7	**0.01**
Foliage height diversity	1.5 ± 0.1	1.4 ± 0.3	0.10
Total number of shrub stems	27.1 ± 30.9	87.8 ± 100.7	**0.006**
Total number of tree stems	9.9 ± 4.6	12.1 ± 8.8	0.23
Number of boxelder stems	25.0 ± 28.9	3.3 ± 6.7	**<0.001**
Number of willow stems	5.4 ± 16.1	61.6 ± 93.0	**0.006**
Number of cottonwood stems	0.6 ± 1.9	2.5 ± 4.9	0.08
Number of woody plant species	3.0 ± 1.7	4.1 ± 2.5	**0.04**
Plant species diversity (Shannon-Weaver Index)	0.587 ± 0.470	0.794 ± 0.645	0.14

Comparisons of used versus unused sites within occupied patches. — We compared habitat variables from 152 Willow Flycatcher nest sites with 40 Unused sites (defined here as gridpoints in occupied patches >100 ft from the nearest flycatcher nest). Nest sites differed significantly from unused sites in a variety of ways; these are summarized in Table 2, and Figures 14, 15 & 16. In general, in the patches where they occur, Willow Flycatchers prefer to nest in microsites that have high canopy closure, moderate canopy height, dense foliage in the subcanopy, a high density of trees but few very large trees, and many boxelders and willows (Figs. 14 & 15). Foliage density was significantly more patchy around nest sites than at unused sites (Fig. 16), suggesting that flycatchers key in to heterogeneous foliage, rather than just dense foliage *per se*. Microsite heterogeneity is also suggested by the higher variation in ground cover found at nest sites (Fig. 14). However, there was relatively little variation in canopy cover or height at nest sites (Fig. 14).

Table 2. Summary of habitat variables found to differ significantly (P<0.05) between Willow Flycatcher nest sites and unused sites (random points >100 ft. from nest sites) within occupied patches, and the direction of those differences.

Variable	value at nest sites relative to unused sites
Average ground cover (%)	lower
Coefficient of variation in % ground cover	higher
Average canopy cover (%)	higher
Coefficient of variation in % canopy cover	lower
Average canopy height	lower
Coefficient of variation in canopy height	lower
Foliage density @ 3 - 10 m	higher
Patchiness	higher
Number of tree stems	higher
Total basal area of woody stems	lower
Number of boxelder stems	higher
Number of willow stems	higher

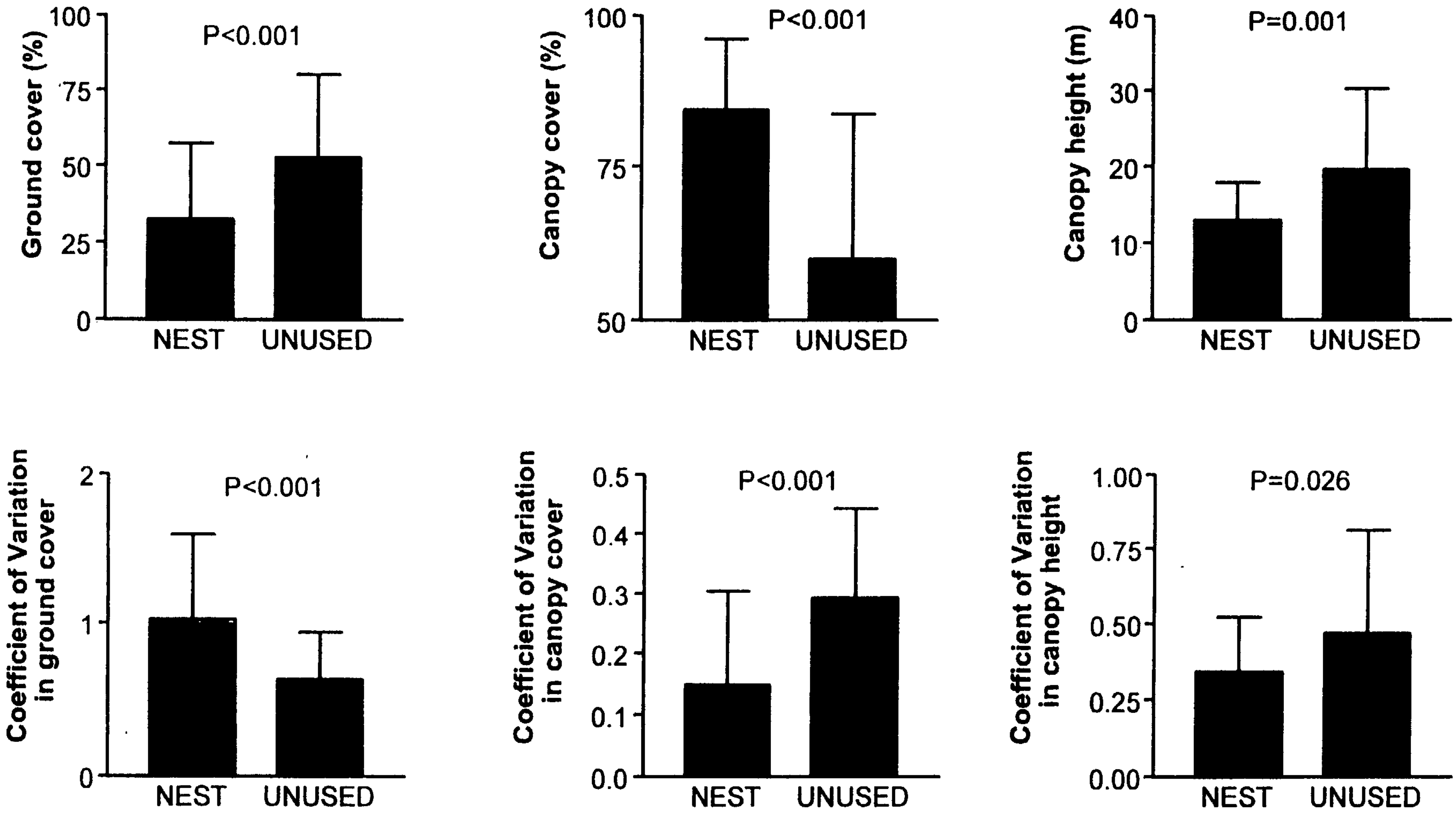


Figure 14. Comparisons of canopy cover, canopy height, and ground cover values and variation between Willow Flycatcher nest sites and unused sites. See Methods for variable definitions.

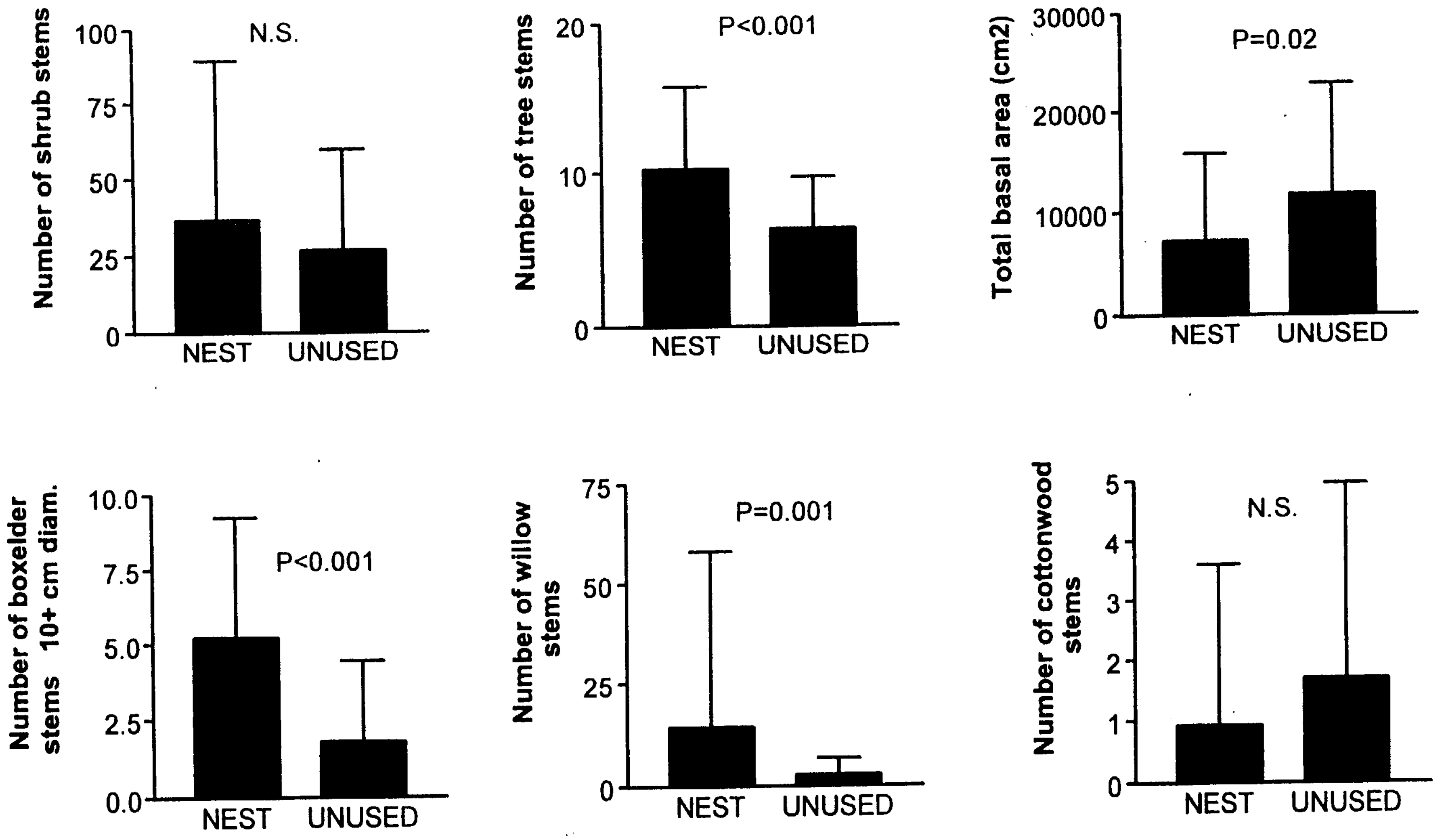


Figure 15. Comparisons of stem counts and basal area values between Willow Flycatcher nest sites and unused sites. See Methods for variable definitions.

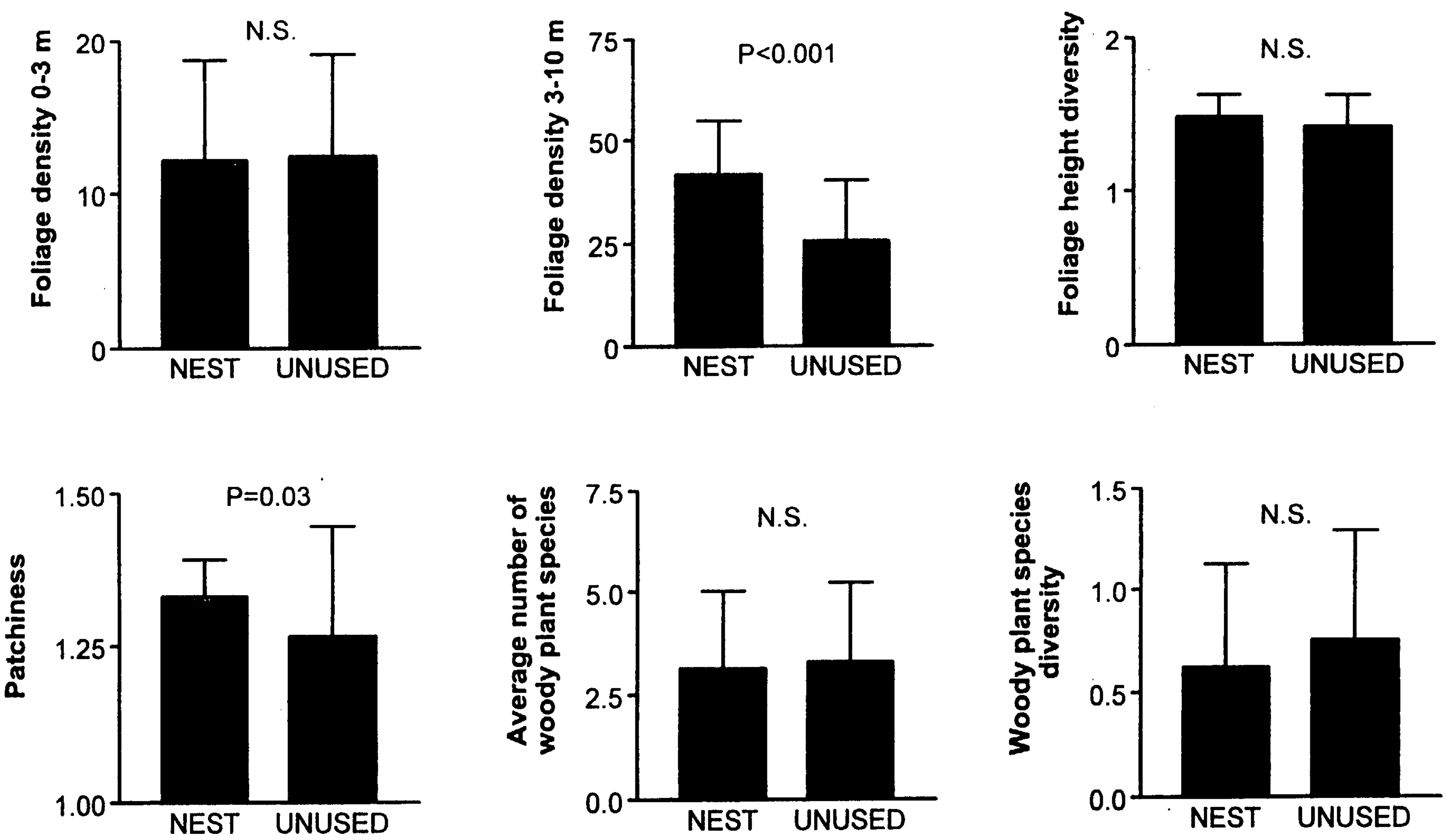


Figure 16. Comparisons of foliage density, foliage diversity, and woody plant species diversity between Willow Flycatcher nest sites and unused sites. See Methods for variable definitions.

Willow Flycatcher banding. — In 1998, we netted Willow Flycatchers in the Fort West Ditch site and in the SE1 patch. A total of 37 adult and one fledgling flycatcher was caught, color-banded, and released. Of the adults that could be sexed, nine were males and thirteen were females. Eighteen individuals were caught more than once. One individual banded on the Fort West Ditch was later found breeding (successfully) in patch NW3, a distance of approximately 3.5 km. No other banded bird appeared to move during the course of the breeding season.

AVIAN COMMUNITY STRUCTURE

Territorial birds. — A total of 78 bird species were recorded while spot-mapping the six focal patches. Of these, 49 were positively identified as breeding within the plots (Appendix). Most of the other 29 species were known to breed nearby on the U-Bar, either locally in small numbers (e.g., Zone-tailed Hawk *Buteo albonotatus*), in habitats other than riparian woodland (e.g., Cliff Swallow *Hirundo pyrrhonota*), or prior to the start of spot-mapping (e.g., Great Horned Owl). The number of breeding birds ranged from 23 to 33 species per plot (Table 3). The number of breeding bird species was directly and strongly correlated with patch size: the larger the patch, the more species were present (Fig. 17). The pattern of species diversity among patches did not mirror exactly the species richness. The most speciose patch, SE1, had the second lowest diversity value, while the NE1 patch, with fewer species, had a much higher diversity value (Table 2). This apparent paradox is because the Shannon-Weaver Diversity Index weights species number by evenness of distribution. Thus, a patch with a moderate number of species that are more-or-less uniformly common (like NE1) has a higher diversity index than a patch like SE1 that has more species, some of which are abundant but many that are uncommon or rare. In the case of SE1, the abundant species were Willow Flycatcher and Yellow-breasted Chat (see Appendix).

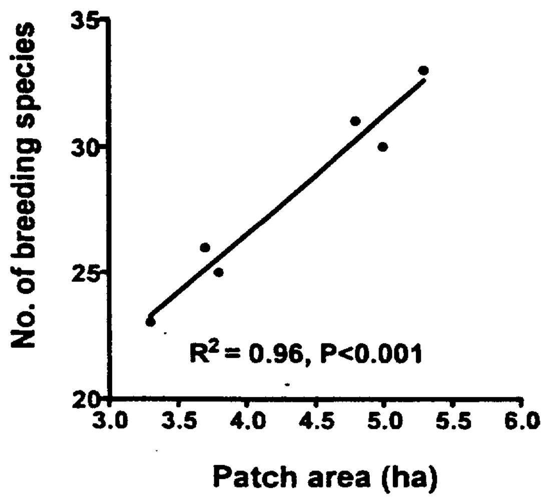


Figure 17. Correlation of patch area and number of bird species breeding in the patch.

The total number of breeding territories ranged from 99 to 190.5 per patch (Table 2). Estimated densities of breeding birds were very high, ranging from 815 prs/40 ha at the Fort West Ditch site to 1343 prs/40 ha in the SE1 patch.

Table 3. — Breeding bird densities and diversity in six focal riparian patches in the Cliff-Gila Valley, based on averages of 1997 and 1998 data.

Patch	No. breeding bird species	No. all bird territories	Sp. diversity[1]	No. WIFL territories[2]	Density (prs/ 40 ha)[3]
Fort West Ditch	30	109.5	3.02	8	815
NE1	25	111.0	3.01	3	1061
NW1	31	171.0	2.85	7	1319
NWS	26	121.0	2.93	5	1176
SE1	33	190.5	2.84	41	1343
SWS	23	99.0	2.77	9	1107

[1] Calculated using the Shannon-Weaver Diversity Index.
[2] Differences between these values and those reported from protocol survey results are because these represent the number of territories falling within spot-mapping grids, which did not cover the entire area of patches.
[3] Conservative estimates include only 10% of dove territories; see Methods.

Nests. — A total of 435 nests were found for 38 species other than Willow Flycatcher in the six focal patches; in addition, two Yellow-billed Cuckoo nests were located in nonfocal patches. Twenty or more nests were found for 7 species: Mourning Dove: 75; Lesser Goldfinch (*Carduelis psaltria*): 44; Black-chinned Hummingbird (*Archilochus alexandri*): 43; Western Wood-Pewee (*Contopus sordidulus*): 35; Yellow-breasted Chat (*Icteria virens*): 29; European Starling (*Sturnus vulgaris*):25; and Yellow Warbler (*Dendroica petachia*): 22. Of the species listed at the state or federal level as threatened, endangered, or sensitive, we found 2 nests of Common Black-Hawk (*Buteogallus anthracinus*), 6 nests of Yellow-billed Cuckoo (*Coccyzus americanus*), 1 nest of Gila Woopecker (*Melanerpes uropygialis*); and 4 nests of Abert's Towhee (*Pipilo aberti*).

Cowbird Parasitism. — We observed cowbird parasitism of several species in the Cliff-Gila Valley in 1998. Yellow Warblers were the most frequently parasitized species, with approximately 25% of nests that we could see into containing cowbird eggs. Other species that we know were parasitized are Vermilion Flycatcher (*Pyrocephalus rubinus*), Plumbeous Vireo (*Vireo plumbeus*), Lucy's Warbler (*Vermivora luciae*), Yellow-breasted Chat, and Blue Grosbeak (*Guiraca caerulea*). The majority of cowbird fledglings observed were fed by Yellow Warblers. Other species that successfully fledged cowbirds included Vermilion Flycatcher, Lucy's Warbler, and Yellow-breasted Chat, in addition to Willow Flycatcher.

DISCUSSION

Willow Flycatcher nesting success. — As in 1997, Willow Flycatchers constituted one of the most common breeding species in the habitat patches surveyed. The observed nesting success rate (43%) was lower than that observed in 1997 (55%). This reduction in nesting success may be due to several factors, including stochastic variation in predator numbers or other factors affecting flycatcher breeding, increased rates of weather-induced nest failure, or a larger sample of nests found in suboptimal habitat due to population growth and/or increased numbers of observers. This level of nest success still compares favorably with other sites that lack cowbird control programs, as well as a number of sites (e.g., Kern River) with extensive cowbird control programs (McCarthey *et al.* 1998). It is a typical success rate for a small migratory songbird (Martin 1995). Predation was the major cause of nest failure by far (Fig. 8)

Cowbird parasitism rates were higher in 1998 (27%) than in 1997 (14.7%), although both figures are suspect because of the uncertain status of the many high nests. It is likely that the actual parasitism rate is lower than the observed rate because the probability of parasitism decreases with nest height in almost all species (Best & Stauffer 1980, Briskie *et al.* 1990). Not all flycatcher parents accepted cowbird eggs (approximately 64%). Many abandoned their nests immediately when a cowbird egg appeared. Few parasitized nests produced cowbird fledglings, as most of those where cowbird eggs were accepted were depredated.

The patch-wise parasitism rate was negatively correlated with the estimated density of female cowbirds within a patch — the more cowbirds, the less likely a Willow Flycatcher nest was to be parasitized. This reason for this counter-intuitive result is unclear. One possibility is that cowbird density may be correlated with the total number of potential host species within a patch, and that higher densities of alternate hosts serves to dilute the effect of more cowbirds on flycatchers. Further analyses are needed to verify this hypothesis.

Nesting success appeared to vary among nest substrates, perhaps because nest heights varied among substrates and nest success was correlated with nest height (Figs. 5 & 7). Parasitism rates also varied among substrates (Fig.11). Over 45% of nests in Russian olive were parasitized; these nests tended to be on patch edges. Nests in willows were also parasitized relatively frequently, and also tended to be on patch edges (Fig. 11). In contrast, nests in boxelder were parasitized only about 15% of the time (or less, as most of the highest nests of uncertain content were in boxelder).

Habitat preferences. — Our vegetation analyses suggest that Willow Flycatchers have very distinct microhabitat preferences, even within individual patches. They actively prefer boxelder and avoid willow as a nesting subtrate (Fig. 3). Willows are a favored nesting substrate in other regions (Harris 1991, McCarthey *et al.* 1998), but in few if any other areas do flycatchers have the choice of both boxelder and willow. Flycatchers may prefer boxelder in the Cliff-Gila Valley because they have higher canopy cover and denser foliage than willows.

Within occupied patches, flycatchers prefer areas with dense canopy cover, dense subcanopy foliage, moderate canopy height, large numbers of trees, boxelders, and willows. Heterogeneity in ground cover and foliage density appear to be preferred as well (Table 2).

Avian community structure. — The Cliff-Gila Valley supports a diverse and extremely populous community of breeding birds. The densities of birds found in 1998 exceeded those reported in 1997, probably because of better estimates of the number of early-breeding species at the site (e.g., Lucy's Warbler, Abert's Towhee). The site contains the highest densities of non-colonial breeding birds ever recorded in North America (Carothers *et al.* 1974, Anderson *et al.* 1983, R.R. Johnson, personal communication).

Conservation implications. — The Cliff-Gila Valley provides critical habitat for the largest population of Southwestern Willow Flycatchers. In addition, the area supports significant numbers of other sensitive, threatened and endangered species, such as Common Black-Hawk, Yellow-billed Cuckoo, Gila Woodpecker, Brown-crested Flycatcher (*Myiarchus tyrannus*), Bell's Vireo (*Vireo bellii*), and Abert's Towhee.

It is noteworthy that the numbers of birds and nesting success rates tended to be higher, and cowbird parasitism rates lower, in the taller, mature riparian woodland on the U-Bar than in younger, lower vegetation elsewhere in the valley. These mature habitats appear to be associated with the earthern levees along the river that were built for flood control. Although the levees certainly hinder the natural flood regime of the Gila, they allow the growth of secondary successional species such as boxelder that are favored by flycatchers at this site.

The NW1 patch is severely threatened by erosion, due to cutting of the riverbank by the Gila River. The nest tree for one probable flycatcher nest discovered in 1997 (when the patch was not a focal patch) was lost due to bank erosion between 1997 and 1998. Further losses are likely unless the river course changes or the bank is stabilized. In addition to Willow Flycatchers, this patch supports single breeding pairs of several threatened and endangered species: Common Black-Hawk, Yellow-billed Cuckoo, Gila Woodpecker, and Abert's Towhee, which remain at risk.

Future Research Directions

We will continue to monitor nests of flycatchers and other riparian species to obtain better estimates of nesting success and cowbird parasitism, and to get a better handle on year to year variation in those parameters. We will continue to sample vegetation at nests and unused sites to develop sufficiently large sample sizes to (1) create a logistic regression model of habitat preferences and habitat correlates of nesting success and nest parasitism.

We will quantify habitat features in patches not occupied by flycatchers to be used in multivariate analyses of landscape-level effects on flycatcher occupancy and nesting success. Those data will be incorporated into a GIS program (Geographic Information System) to create spatially-explicit models. Landscape-level effects have been recognized as a priority resarch need by Arizona Partners in Flight.

We will expand our color-banding program in the coming year to increase sample sizes for estimates of survival, mate and site fidelity, and dispersal in the Cliff-Gila population. These data have also been identified as a priority research need, and the large population in the Cliff-Gila Valley provide a unique opportunity to develop robust sample sizes. By increasing banding of young birds we can document that this population is indeed a source population.

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Appendix

Number of territories and density (pairs/40 ha) per patch, and total number of nests found, of breeding birds in the Cliff-Gila Valley, 1997-98.

	FWD		NE1		NW1		NW Stringer		SE1		SW Stringer		total
SPECIES	terr.	density	terr.	density	terr.	density	terr.	density	terr.	density	terr.	density	nests
Mallard	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	12.3	2
Cooper's Hawk	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1
Common Black-Hawk	0	0.0	0	0.0	1	8.3	0	0.0	1	7.6	0	0.0	2
Red-tailed Hawk	0	0.0	0	0.0	0	0.0	1	10.8	0	0.0	0	0.0	2
American Kestrel	0	0.0	0	0.0	1	8.3	1	10.8	2	15.1	1	12.3	6
Wild Turkey	1	8.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Gambel's Quail	2	15.9	1	10.5	1	8.3	0	0.0	1	7.6	0	0.0	1
Mourning Dove	8	6.4	11	11.5	13	10.8	13	14.0	14	10.6	10	12.3	143
Yellow-billed Cuckoo	0	0.0	1	10.5	1	8.3	1	10.8	2	15.1	2	24.6	8
Western Screech Owl	0	0.0	1	10.5	0	0.0	0	0.0	0	0.0	1	12.3	1
Black-chinned Hummingbird	7	55.8	6	63.0	5	41.4	6	64.6	7	52.9	5	61.5	53
Gila Woodpecker	0	0.0	0	0.0	1	8.3	0	0.0	0	0.0	0	0.0	2
Ladder-backed Woodpecker	1	8.0	1	10.5	0	0.0	1	10.8	0	0.0	0	0.0	1
Hairy Woodpecker	0.5	4.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Northern Flicker	1	8.0	2	21.0	2	16.6	2	21.5	2	15.1	1.5	18.4	8
Western Wood-Pewee	4	31.9	6	63.0	15	124.2	4	43.0	6	45.3	1	12.3	47
Willow Flycatcher	8	63.8	3	31.5	7	57.9	5	53.8	41	309.6	9	110.7	257
Vermilion Flycatcher	0	0.0	4	42.0	7	57.9	3	32.3	1	7.6	0	0.0	21
Ash-throated Flycatcher	1	8.0	0	0.0	3	24.8	1	10.8	2	15.1	1	12.3	4
Brown-crested Flycatcher	1	8.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2
Cassin's Kingbird	0	0.0	4	42.0	6	49.7	3.5	37.7	1.5	11.3	1	12.3	22
Western Kingbird	0	0.0	0	0.0	1	8.3	0	0.0	1	7.6	0	0.0	3
Violet-green Swallow	3	23.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4
Western Scrub-Jay	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1
American Crow	0	0.0	0	0.0	0	0.0	0	0.0	1	7.6	0	0.0	1
Bridled Titmouse	1.5	12.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
White-breasted Nuthatch	1	8.0	2.5	26.2	1	8.3	2	21.5	2	15.1	1	12.3	5
Bewick's Wren	4	31.9	4.5	47.2	6	49.7	8	86.1	7	52.9	7	86.1	22
American Robin	0	0.0	1	10.5	1	8.3	2	21.5	1	7.6	0	0.0	4
European Starling	0	0.0	3	31.5	12	99.3	4	43.0	7	52.9	0	0.0	30
Bell's Vireo	0	0.0	0	0.0	0	0.0	0	0.0	1	7.6	0	0.0	0
Plumbeous Vireo	1	8.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2
Lucy's Warbler	7.5	59.8	8	84.0	15	124.2	11	118.4	7	52.9	10	123.0	6
Yellow Warbler	8	63.8	11	110.2	14	115.9	11.5	123.7	17	128.4	10	123.0	30
Common Yellowthroat	3	23.9	0	0.0	0	0.0	0	0.0	4	30.2	0	0.0	3
Yellow-breasted Chat	13	103.6	7	73.5	5	41.4	0	0.0	20	151.0	7	86.1	59
Summer Tanager	3	23.9	3.5	36.7	4	33.1	3	32.3	4	30.2	3	36.9	13
Northern Cardinal	1	8.0	0	0.0	0	0.0	0	0.0	2	15.1	0	0.0	3
Black-headed Grosbeak	2	15.9	2	21.0	2	16.6	4	43.0	3	22.7	4	49.2	8
Blue Grosbeak	3	23.9	2	21.0	3	24.8	4	43.0	3	22.7	5	61.5	14
Indigo Bunting	2	15.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1
Spotted Towhee	5	39.9	2	21.0	4	33.1	0	0.0	6	45.3	0	0.0	10
Abert's Towhee	0	0.0	0	0.0	1	8.3	0	0.0	1	7.6	1	12.3	5
Lark Sparrow	0	0.0	0	0.0	1	8.3	1	10.8	0	0.0	0	0.0	0
Brown-headed Cowbird	5	39.9	7	73.5	6	49.7	5	53.8	3	22.7	7	86.1	NA
Bullock's Oriole	1	8.0	6	63.0	7	57.9	4	43.0	3	22.7	0.5	6.1	18
House Finch	4	31.9	5	52.5	11	91.0	12	129.1	2	15.1	3	36.9	23
Lesser Goldfinch	7	55.8	8	84.0	14	115.9	8	86.1	15	113.3	8	98.4	59

ATTACHMENT "C"

REPRODUCTIVE SUCCESS AND HABITAT REQUIREMENTS OF THE SOUTHWESTERN WILLOW FLYCATCHER IN THE CLIFF-GILA VALLEY, NEW MEXICO

Final Report for the 1999 Field Season

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EXECUTIVE SUMMARY

Due to a strong La Niña pattern, 1999 was a year of weather extremes in the Cliff-Gila Valley. An extended and windy drought lasting from autumn of 1998 through June 1999 was finally broken by exceptionally heavy monsoon rains beginning in late June. This adverse weather appeared to have a negative impact on nest success of Willow Flycatchers. In 1999, we located 146 flycatcher nests. Of these, 92 were known to have failed. Many early nests were either damaged by wind or abandoned prior to egg-laying. Excluding those known to have been abandoned prior to laying, simple nest success was about 33%, well below the levels recorded in 1997-98. Anecdotal observations suggest that this low level of per-nest success may reflect a high incidence of multiple nesting attempts per pair. Estimated rates of cowbird parasitism were 15.6 %, the lowest recorded in the three years of this study. Predation was the most frequent cause of nest failure for nests where causes were known.

As in previous years, flycatchers nested most frequently and preferentially in box elder. They tended to avoid willow except in mostly pure stands of either coyote or Goodding's willow. We recorded the first known nests placed in canyon grape and the exotic Siberian elm. Flycatchers placed their nests high (mean = 7.5 m). The average relative height of nests within the nest plant was 63.9%, almost the same as the relative height in native plants in Arizona and for the eastern subspecies (*E. t. traillii*) in shrubby habitats in Wisconsin. This congruence suggests relative nest height, rather than absolute height, may be of importance to Willow Flycatchers.

Although not experimental tests, we were able to assess the effects on flycatchers of grazing and irrigation as practiced on the U Bar Ranch by comparing data from patches that were grazed versus not grazed, and patches that were on or not on a ditch. Grazing had no apparent impact (positive or negative) on flycatcher density, nest success, or cowbird parasitism. In contrast, flycatchers appeared to benefit from irrigation: they occurred in significantly higher densities in patches associated with irrigation ditches.

INTRODUCTION

The Species. — The Southwestern Willow Flycatcher *(Empidonax traillii extimus)* is a neotropical migrant passerine that ranges from southern California and Baja California eastward through Arizona, southern Utah, southern Colorado, New Mexico, and trans-Pecos Texas (Unitt 1987). This species is an obligate riparian specialist, nesting in dense vegetation associated with watercourses. In the southwest, nesting is almost always in the vicinity of surface water or saturated soils (U.S. Fish and Wildlife Service 1995).

Populations of the southwestern willow flycatcher are thought to have declined significantly during this century, primarily due to extensive loss and conversion of riparian breeding habitats (Unitt 1987, U.S. Fish and Wildlife Service 1995). Loss and modification of riparian habitats have been attributed to many factors, including water diversion and impoundment, changes in fire and flood frequency due to hydrological alterations, livestock overgrazing, replacement of native riparian vegetation by nonnative species, urban development, and recreational activities (Rea 1983, Kreuper 1993, U.S. Fish and Wildlife Service 1995). Additionally, a high incidence of nest parasitism by brown-headed cowbirds (*Molothrus ater*) has been reported from several sites, resulting in low reproductive success. Cowbirds lay their eggs in the nests of other species (hosts), where cowbird chicks are raised by the host parents. For small hosts, parasitized nests rarely fledge any host young (Brittingham & Temple 1983). Nest parasitism levels of more than 50% have been documented for populations at the Kern River, California (Harris 1991) and the Grand Canyon (Brown 1994). Frequently flycatchers respond to the laying of cowbird eggs in their nests by abandoning and renesting (Whitfield & Strong 1995).

In 1993, the U.S. Fish and Wildlife Service proposed to list *E. t. extimus* as an endangered species and to designate critical habitat. In February of 1995, the USFWS listed *E. t. extimus* as endangered, although no designation of critical habitat was made (U.S. Fish and Wildlife Service 1995). The subspecies has also been listed at the state level in New Mexico, Arizona, and California (Arizona Game and Fish Department 1988, New Mexico Department of Game and Fish 1988, California Department of Fish and Game 1992).

The Cliff-Gila Valley population. — Since its listing as an endangered species, numerous surveys have been conducted across the range of the flycatcher to locate extant populations and to estimate their size. Flycatchers have been found breeding at about 109 sites throughout the southwestern United States (Finch 1999). Approximately 78% of extant sites consist of 5 or fewer territories. The entire known breeding population in 1996 was estimated at just over 500 pairs (Finch 1999). By far the largest known breeding concentration of Southwestern Willow Flycatchers is located in the Cliff-Gila Valley, Grant County, New Mexico. This population was estimated at 184 pairs in 1997 (Parker 1997), and at 235 pairs in 1998 (P. Boucher, personal communication; Stoleson and Finch, unpublished data). These birds are located primarily on private property owned by the Pacific Western Land Company, a subsidiary of Phelps Dodge Corporation, and managed by the U-Bar Ranch. An additional 33 pairs occur on the adjacent Gila National Forest and other private holdings. Habitat preferences of flycatchers in this population differ, at least superficially, from those reported elsewhere (Hull and Parker 1995, Skaggs 1996, Stoleson and Finch 1997), and from populations of other subspecies.

OBJECTIVES

Our goals for this study in 1999 were:

1. locate and monitor nests of Willow Flycatchers to assess levels of nesting success, cowbird parasitism and predation.
2. characterize and quantify vegetation at nests sites, territories, and unused sites within occupied habitat patches.
3. band adult and nestling Willow Flycatchers to allow individual identification.

This report presents the results of the third year of the study.

METHODS

Study area. — The Cliff-Gila Valley of Grant County, NM, comprises a broad floodplain of the Gila River, beginning near its confluence with Mogollon Creek and extending south-southwest toward the Burro Mountains. The study was primarily conducted from just below the US Route 180 bridge upstream to the north end of the U-Bar Ranch (approximately 5 km). In addition, flycatchers were studied in two disjunct sections of the valley: (1) the Fort West Ditch site of the Gila National Forest and adjacent holdings of The Nature Conservancy's Gila Riparian Preserve, located about 9 km upstream of the Route 180 bridge, and (2) the Gila Bird Area, a riparian restoration project comprising lands of the Gila National Forest and Pacific-Western Land Company, located some 8 km downstream of the Route 180 bridge. Most of the upper Gila Valley consists of irrigated and non-irrigated pastures used for livestock grazing and hay farming. Elevations range from 1350 to 1420 m.

The Gila River and nearby earthen irrigation ditches are lined with riparian woodland patches of various ages and composition. Most patches support a mature woodland (>25 m canopy) of Fremont cottonwood (*Populus fremontii*), with a subcanopy of mixed deciduous trees including box elder (*Acer negundo*), Goodding's willow (*Salix gooddingii*), velvet ash (*Fraxinus velutinus*), Arizona walnut (*Juglans major*), Arizona sycamore (*Platanus wrightii*), Arizona alder (*Alnus oblongifolia*) and Russian olive (*Elaeagnus angustifolia*). The understory is composed of shrubs including three-leaf sumac (*Rhus trilobata*), false indigo (*Amorpha fruticosa*), New Mexico olive (*Forestieria neomexicana*), forbs, and grasses. Fewer patches support a shrubby, early successional growth of seepwillow (*Baccharis glutinosa*), coyote and bluestem willows (*Salix exigua* and *S. irrorata*), and saplings of the species mentioned above. Most habitat patches are less than 5 ha in area. The FS Fort West Ditch site and the Gila Bird Area are generally more open than patches on the U-Bar. In addition to the primary patches of riparian woodland along the Gila itself, numerous stringers of riparian vegetation extend along many of the earthen irrigation ditches. These stringers contain the same plant species as larger forest patches, but rarely exceed 10 m in width.

This study concentrated on three large riverine patches and two stringer patches on the U-Bar Ranch (see Fig. 1: SE1, NW1, NE1, SW Stringer, and NW Stringer) and the FS Fort West Ditch site. In addition, flycatchers were studied in other riparian patches as time allowed.

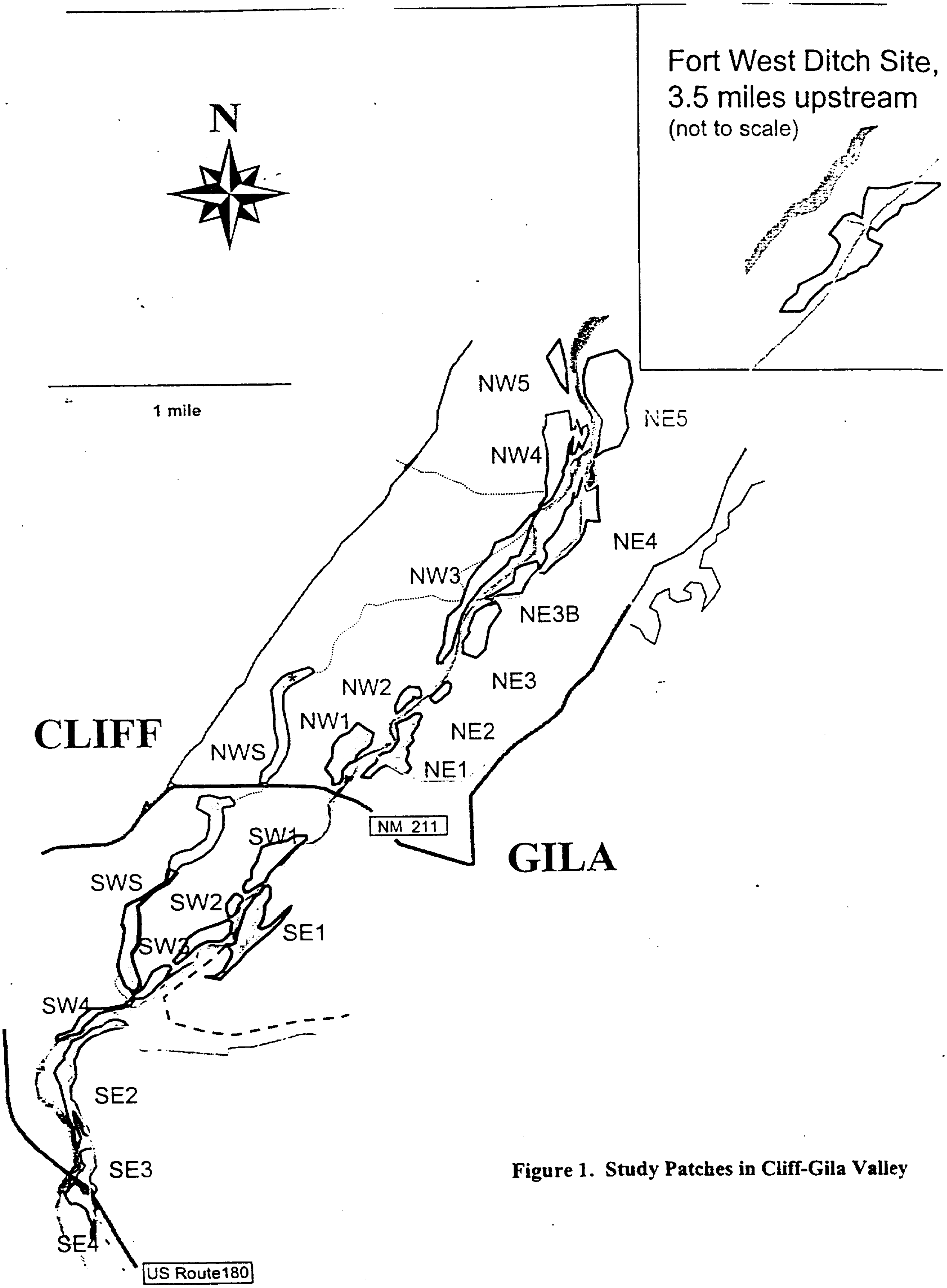

Figure 1. Study Patches in Cliff-Gila Valley

Spot mapping. — Territories of all breeding land birds were determined using the spot mapping method (Robbins 1970, Bibby et al. 1992, Ralph et al. 1993). In each focal patch, a grid of 100 ft squares was established and marked with flagging tape. We conducted spot-mapping censuses within each grid every 2-3 days, beginning within 15 minutes of dawn (Bibby et al. 1992). Following mapping, observations were transferred from the daily map to master maps for each species. From the master maps we determined the number of breeding territories of all species for each patch. We calculated estimates of the density of breeding birds (all species) for the areas that were spot-mapped. Because the territories of large and/or wide-ranging birds (e.g., quail, raptors, crows, ravens, swallows, jays, and cuckoos) could potentially cover two or more patches and/or surrounding nonforested land, a territory was assigned to a particular patch only if the nest was located within the patch. Second, Mourning Doves (*Zenaida macroura*) breed in high densities in riparian habitats but forage mainly in open areas. Because including all doves found in a patch in calculations is likely to bias estimates of density, we followed Anderson et al. (1983) in using only 10% of the observed dove population.

Nest monitoring. — Nest searches were conducted on a daily basis following spot-mapping sessions. Within focal patches, searches were conducted for nests of all species. Only flycatcher and cuckoo nests were searched for in additional patches. Nests were monitored every 3-7 days, following a modified version of proposed protocols suggested by the Arizona Game and Fish Department (Rourke et al. 1999). Nest contents were observed using pole-mounted mirrors or videocameras, or 15X spotting scopes. Nests that were abandoned or destroyed were examined for evidence (e.g., cowbird eggs, mammal hairs) to ascertain causes of nest failure. We considered a nest successful if: (1) parent birds were observed feeding one or more fledged young; (2) parent birds behaved as if dependent young were nearby when the nest was empty (defensive or agitated behavior near nest); or (3) nestlings were in the nest within one or two days of the estimated fledge date. We considered a nest failed if: (1) nest contents disappeared before fledging of young was possible, assuming 10-12 d required for fledging (depredation), (2) the nest contained no Willow Flycatcher young but contained cowbird eggs or chicks (parasitized), (3) the nest was deserted after eggs had been laid (desertion), or (4) the nest was abandoned prior to egg laying (abandonment).

Habitat Measurements. — We continued sampling vegetation at flycatcher nests and unused points within the focal patches in 1999, using a modified BBIRD methodology (Martin et al. 1997). Unused points were defined as points on the spot-mapping grid that were at least 100 ft away from the nearest Willow Flycatcher nest; we based this definition on the fact that most flycatcher territories appeared to have radii much smaller than 100 ft. At each unused point and nest site, a 0.02 ha plot (radius = 8 m) was placed centered on the nest tree, or on the nearest tree to the gridpoint for unused points. At the center of the plot and eight other points (4 and 8 m from the center in each of the four cardinal directions), we measured canopy height using clinometers, percent canopy cover using densiometers, and estimated percent ground cover. Vertical foliage density was measured at 2, 4, 6 and 8 m in each direction from the center tree by counting hits of vegetation against a 10 m vertical pole marked in 1 m increments. Within the 0.02 ha plot, trees ($\geq$ 10 cm dbh) of all species were counted and measured (dbh). Shrubs and saplings (< 10 cm dbh) were counted and measured within a 4 m radius of the center tree. For nest sites we also recorded nest plant species, nest height, and distance, direction from the trunk.

For each sample point we calculated average ground and canopy cover and average canopy height (all = mean of 9 measurements per point); foliage density index (sum of 1 m increments touched by foliage) for understory (0-3 m in height, for a maximum score of 48 per point) and mid-canopy (3-10 m in height, for a maximum score of 112 per point); the sum of shrub/sapling (<10 cm diameter) stems and tree (≥ 10 cm diameter) stems by species and size class (<1cm, 1-5 cm, 5-7.5 cm, 7.5-10 cm, 10-30 cm, 30-50 cm, 50-70 cm, >70 cm). From these values we also calculated the total number of stems of willow and box elder per point, an estimate of the total basal area of woody species per point, woody plant species richness (number of species of trees and shrubs per point), and plant species diversity (using the Shannon-Weiner Diversity Index). We calculated several variables to estimate the degree of habitat heterogeneity at points: patchiness (the diversity of foliage density among the four cardinal directions, using the Shannon-Weiner Diversity Index); and the coefficient of variation in measures of canopy cover, canopy height, and ground cover at each point.

Analyses. — We compared habitat values of unused points (n=89) to those at nest sites (n=127) using independent sample t-tests when data were normally distributed, or Mann-Whitney U-Tests when they were not. Although we performed multiple statistical comparisons from the single set of data, we did not adjust our experiment-wise alpha level to minimize the risk of Type I errors because the modest sample sizes used for unused points are already prone to Type II errors, and we wanted to maximize our ability to detect trends. Those variables found to differ significantly between unused and nest points were included in a logistic regression analysis. When high correlation between pairs of variables suggested problems of collinearity, we dropped the variable we considered to be less biologically relevant. We chose as a final regression model that which explained the greatest deviance with the least number of parameters; we used likelihood-ratio tests between nested models to assess the explanatory power of individual variables (Menard 1995).

To assess whether flycatchers used nest substrates randomly, we calculated an index of availability for each nest tree species to compare usage with availability. Because flycatcher nests were found in vegetation of all size classes 1 cm DBH and greater, we pooled all size classes > 1 cm DBH as potential nest substrates. A total stem count for each species was calculated from all nest sites. The relative availability of a particular plant species *x* was calculated as: total number of stems for species *x* / total number of all stems. The numbers of used versus unused stems were compared using chi-square analyses.

RESULTS & DISCUSSION

CLIMATE IN 1999

Due to a strong La Niña pattern, 1999 proved to be a year of weather extremes in the Cliff-Gila Valley (Table 1). Severe drought began in late 1998 and persisted into June. Precipitation remained less than 30% of normal during this time, and water levels were very low in the Gila River. By late May, water flow in the Gila and Fort West irrigation ditches became irregular. Strong winds typical of early spring lasted well into June (pers. observation). Monsoon rains began earlier than normal in mid-June, and became torrential in July. Sufficient rain fell in July (182% of normal for the month) to make up for the water deficit of the previous 10 months. It seems likely that the extreme wind and drought followed by heavy rains had a negative impact on reproductive success of Willow Flycatchers in the area.

Table 1. Precipitation measured at Cliff, NM for January-August 1999, compared to averages for 1936-1999. Data are from the Western Regional Climate Center.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
1999 precipitation (in.)	0.11	0.00	0.35	0.39	0.08	0.93	5.09[a]	1.88
Average precipitation (1936-1999)	1.01	0.96	0.86	0.33	0.36	0.50	2.79	2.84
Deviation from normal (in.)	-0.90	-0.96	-0.51	0.06	-0.28	0.43	2.30	-0.96
Cumulative deviation from normal	-0.90	-1.86	-2.37	-2.31	-2.59	-2.16	0.14	-0.82
Expected cumulative total	1.01	1.97	2.83	3.16	3.52	4.02	6.81	9.65
% of normal (cumulative)	10.9	5.6	16.3	26.9	26.4	46.3	102.1	91.5

[a] data set is missing one day.

WILLOW FLYCATCHERS

Nests. — We found a total of 146 nests in 1999, including 120 on the U-Bar Ranch and an additional 26 on nearby lands of the Gila National Forest, The Nature Conservancy, and other private landowners (Fig. 2). As in previous years, flycatchers used box elder most frequently for nesting (70.3% of nests). Willows (17.8%) and cottonwoods (6.2%) were also used frequently as nest substrates. Flycatchers also placed nests in Arizona alder (3), seepwillow (2), Russian olive, canyon grape, and Siberian elm (1 each). The last two plants have not been previously reported as willow flycatcher nesting substrate in the Southwest.

Substrate use versus availability. — As in previous years, flycatchers did not use substrates in proportion to their availability within the habitat. Flycatchers showed a strong preference for nesting in box elder ($\chi^2 = 123.5$, df = 1, $p < 0.001$). Box elder comprised 32.1% of the woody stems over 1 cm diameter, yet contained 70% of all nests found. Use of cottonwood, Arizona alder, and Russian olive were in proportion to their overall abundance (all $p > 0.5$). In contrast, willows (both species pooled) and all other species combined were used less than expected by chance ($\chi^2 = 10.7$ and 24.3, respectively, df = 1, $p < 0.001$ for both). The two willow species used made up more than 35% of all stems but were used for less than 12% of nests (Fig. 3). We found no flycatcher nests in the shrubby bluestem willow.

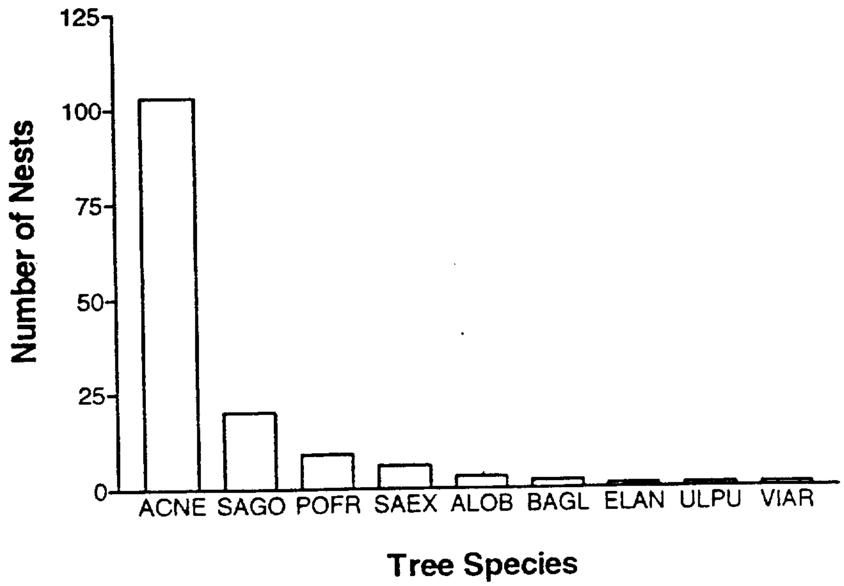

Figure 2. Nesting substrates by southwestern willow flycatchers in the Cliff-Gila Valley, 1999. ACNE = box elder, SAGO = Goodding's willow, POFR = Fremont cottonwood, SAEX = coyote willow, ALOB = Arizona alder, BAGL = seepwillow, ELAN = Russian olive, ULPU = Siberian elm, and VIAR = canyon grape.

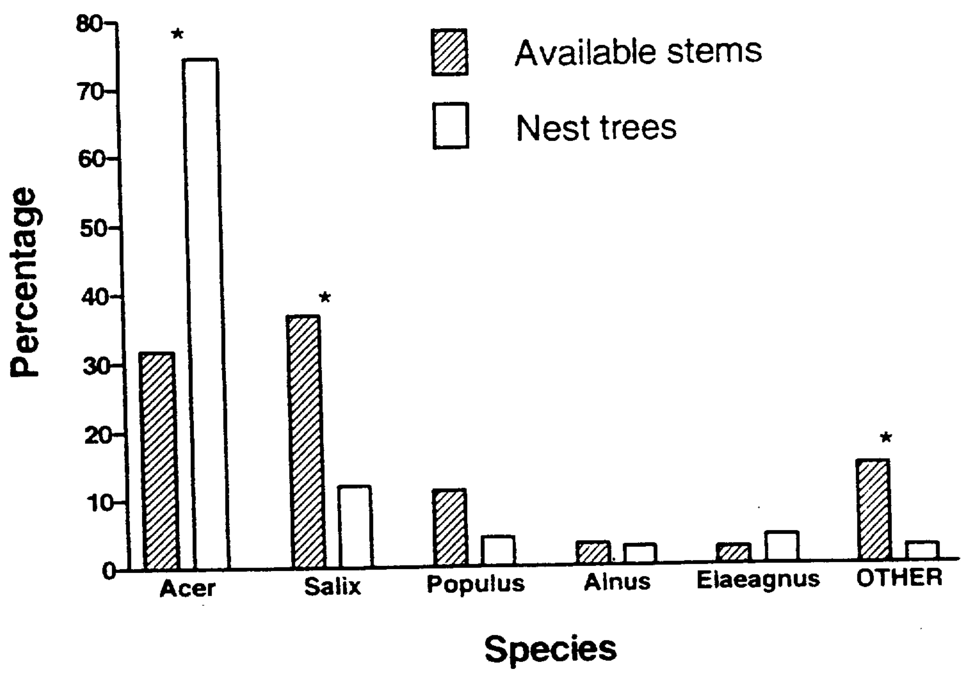

Figure 3. Use versus availability of willow flycatcher nesting substrates. Compared to abundance within the habitat, box elder (*Acer*) was used significantly more, and willows (*Salix*) and all others were used significantly less than expected by chance.

Nest heights. — As in previous years, Willow Flycatchers tended to nest high in the Cliff-Gila Valley. Nest heights ranged from 1.5 to 16.5 m in height, with a mean height of 7.7 ± 3.5 m. Trees and shrubs in which flycatchers built nests averaged 12.1 ± 4.4 m, and ranged from 2.3 to 24.5 m high. As with height, nest trees varied greatly in diameter, from 1.0 cm in coyote willow to 57.5 in box elder (mean = 21.3 ± 13.2 cm). Tree and shrub heights varied greatly among different species, and consequently, nest heights varied among different substrates (Fig. 4)

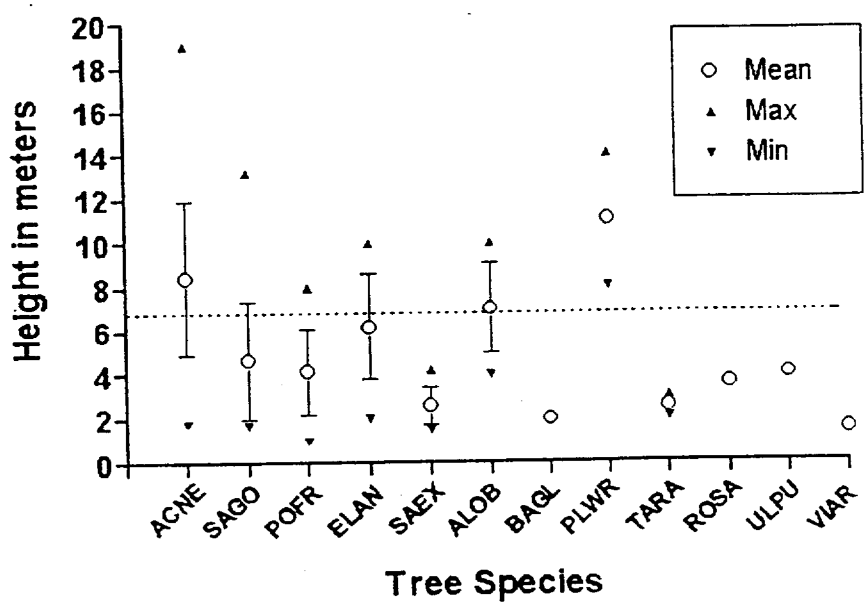

Figure 4. Nest heights (mean, SD, max. and min.) of Southwestern Willow Flycatchers as a function of nesting substrate, based on 403 nests found in the Cliff-Gila Valley 1997-1999. Acronyms as in Figure 1, plus PLWR = *Platanus wrightii*, ROSA = *Rosa multiflora*, TARA = *Tamarix ramosissima*.

In a study of the shrub-inhabiting *E. t. traillii* in Wisconsin, McCabe (1991) measured not only absolute heights but relative heights as well, which he calculated as nest ht/nest plant ht. He found the average relative height in his population to be 62.1 (n = 601); that is, nests were placed 62.1% of the way up the nest plant. In the Cliff-Gila Valley, we found the average in 1999 was 63.9 ± 16.0 (n = 122). Thus, despite the great differences in nest heights (means of 1.4 vs. 7.7 m), the relative vertical placement of nests within the nesting substrate was almost identical in the two populations. Interestingly, we calculated the average relative nest height in native or mixed native/exotic at low-elevation sites in Arizona in 1999 from published data (Paradzick et al. 2000), and found an average of 61.9. Whether this high level of congruence among very different sites is coincidental or not is unclear. Nevertheless, it suggests the possibility that in Willow Flycatchers, absolute nest height may be relatively unimportant compared to the relative nest height within a chosen nest substrate.

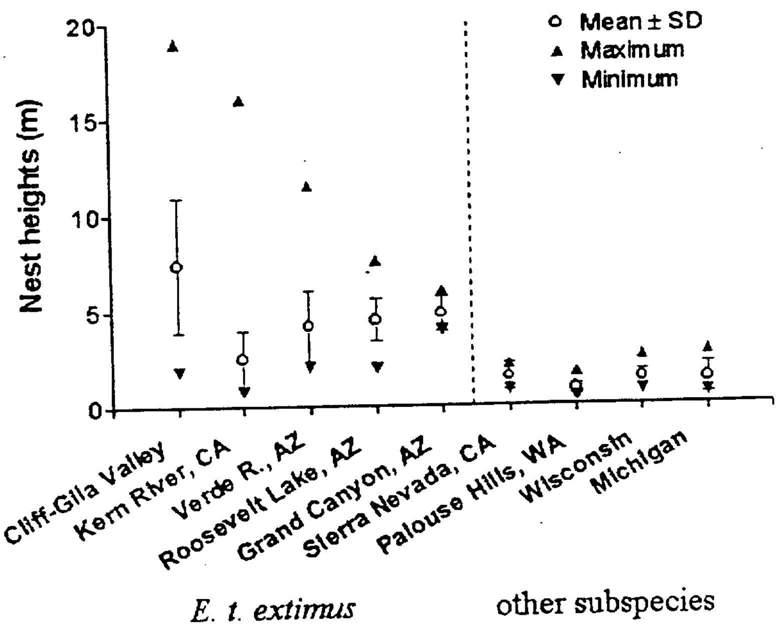

Figure 5. Range of nest heights among populations of Southwestern and other subspecies of Willow Flycatchers, from published data sources. Note that average nest heights are higher in all *extimus* populations than in any population of other subspecies.

Willow Flycatcher nest success. — 1999 was a relatively poor year for nesting by Willow Flycatchers in the Cliff-Gila Valley. Of 128 nests built for which we could determine the outcome, a total of 92 failed (28.1% simple nest success). Numerous nests were abandoned before any eggs were laid, most likely due to wind damage; these probably had little or no impact on seasonal reproductive success by flycatchers. Considering just those nests in which eggs were laid, 69 of 103 nests (67.0%) failed, suggesting a simple nest success rate of 33.3%.

Causes of nest failure. — As in previous years, we were unsure of the cause of most nest failures. Of those we do know, predation was the primary cause of failure for nests in which clutches had been initiated (n = 24). Seven nests failed because they were parasitized by cowbirds, and at least four failed due to direct effects of inclement weather (e.g., wind, heavy rain).

Cowbird parasitism. — Of 45 nests for which parasitism status was known, we found seven flycatcher nests that had been parasitized by brown-headed cowbirds (15.6%). At least one of those successfully fledged flycatcher young. In addition, we found two sets of parent flycatchers feeding cowbird fledglings for which no nest was ever found. This is the lowest level of parasitism we have recorded in three years of study.

Willow Flycatcher banding. — In 1999 we placed individually unique combinations of colored aluminum bands on 35 adult and 3 nestling Willow Flycatchers. Of 23 banded individuals of known sex, 13 were female, the remaining 10 males. We recaptured 4 of 31 birds banded in 1998, all approximately where they were first banded. Another 6 individuals banded in 1998 were resighted in 1999, all but one in approximately the same location as in 1998. We observed additional banded birds, but were unable to determine their band combinations definitively. Our sparse recapture data suggest that flycatchers at this site may exhibit strong site fidelity (unlike that reported from Arizona by Paxton et al. 1997).

Impacts of Cattle Grazing and Irrigation on Willow Flycatchers

Because of the concern over grazing impacts on riparian areas generally, and on Willow Flycatchers in particular, we tested several predictions using existing data on flycatcher populations and nesting success in the Gila River Valley, along with knowledge of grazing management on the U-Bar Ranch. On the ranch, 7 of 21 patches have been excluded from grazing since 1993 (exclusive of trespass cattle); the remainder are grazed primarily during the fall and winter. Additional information comes from ungrazed areas of the Gila National Forest and The Nature Conservancy. We compared average values of flycatcher density, nest success, and cowbird parasitism between patches that are grazed for at least part of the year ($n = 15$), and patches that are excluded from grazing ($n = 11$). Analyses of nest success and parasitism include nests on Forest Service and Nature Conservancy properties. We also compared the per-patch density of flycatchers between patches on the U-Bar associated with an irrigation ditch ($n = 14$) and those not ($n = 7$). All analyses include data from 1997-1999. It must be noted that these are *not* experimental tests of hypotheses, but rather correlative analyses, and therefore causation cannot be inferred. Further, as grazing and water management practices may differ elsewhere, it is unknown what their effects on flycatchers might be.

Effects of grazing on Willow Flycatcher densities. -- Grazing had no apparent impact on flycatcher density on a per-patch basis. The average density (pairs/ha) of breeding Willow Flycatchers did not differ significantly between grazed patches and those excluded from grazing ($t = 0.87$, df=1, $P = 0.40$; Fig. 6).

Effects of grazing on Willow Flycatcher nest success. – We detected no effect of grazing on nest success (Fig. 7). The proportion of nests of known outcome that produced young was similar between nests in grazed patches (37.4%, $n = 227$) and ungrazed patches (43.6%, $n = 101$; $\chi^2 = 1.1$, df = 1, $P = 0.30$). The slight difference is not statistically significant. If the nonsignificant trend reflects real albeit subtle differences, those differences may result from differences in density (see Fig. 6) rather than any impacts of grazing. Experimental data are required to assess this.

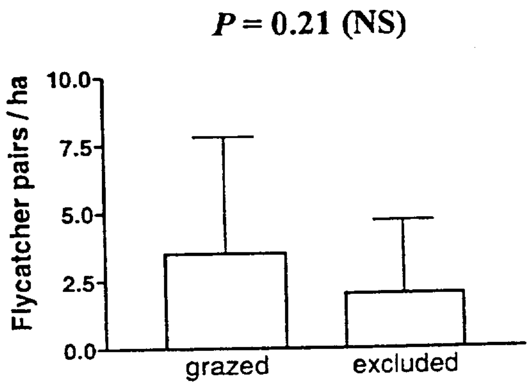

Figure 6. Flycatcher densities in riparian patches excluded from cattle versus patches grazed by cattle, based on population estimates from 1999 survey data.

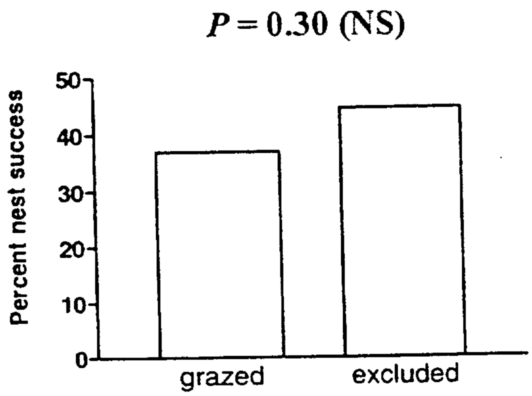

Figure 7. Average success of Willow Flycatcher nests from riparian patches open to cattle and patches excluded from cattle.

Effects of grazing on Willow Flycatcher nest parasitism. – Similarly, we detected no effect of grazing on the likelihood of nest parasitism. The proportion of nests that were parasitized in grazed patches (19.0%, n = 124) was almost identical to that in ungrazed patches (20.0%, n = 46; $\chi^2 = 0.01$, df = 1, $P = 0.91$; Fig. 8). It should be noted that for few of the nests in grazed patches were cattle in the patch while the nest was active. Thus, we find no evidence that livestock grazing, as practiced on the U Bar, has any detectable effect on Willow Flycatchers.

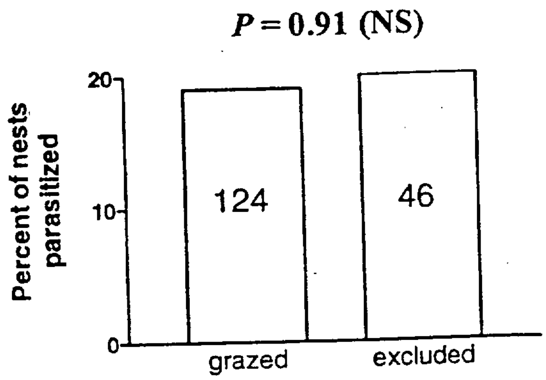

Figure 8. Average rates of cowbird parasitism of Willow Flycatcher nests in riparian patches grazed by cattle and excluded from cattle.

Effects of irrigation on Willow Flycatcher densities. -- In contrast to grazing, irrigation ditches did appear to have a pronounced effect on Willow Flycatcher density (Fig. 9). The density of breeding territories was significantly greater in patches associated with ditches (3.7 ± 4.3 terr/ha) than in patches not associated with ditches (1.3 ± 1.8 terr/ha; Mann-Whitney U = 26.0, 1-tailed $p = 0.04$). This result suggests that the small-scale diversion irrigation as practiced in the Cliff-Gila Valley may increase the quality of riparian habitat for flycatchers, presumably through increases in the extent and degree of hydration.

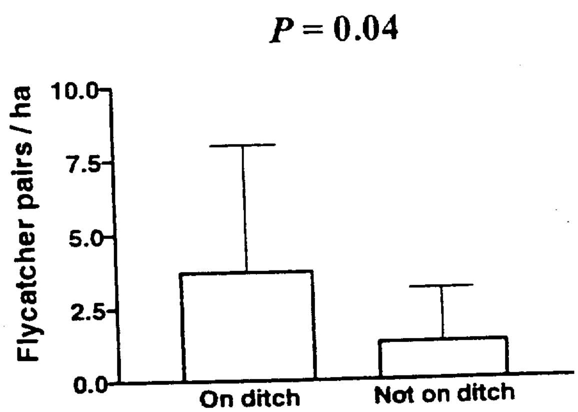

Figure 9. Average densities of Willow Flycatchers in patches associated and not associated with irrigation ditches, based on 1999 population survey data.

Habitat Analyses

Here we present updated assessments of microhabitat use by Willow Flycatchers based on vegetation data collected from 1997-1999.

Comparisons of used versus unused sites. — Microhabitat around Willow Flycatcher nest sites differed from that at unused sites within occupied patches. In univariate comparisons, 13 of 19 habitat variables differed significantly between the two types of plots (Table 2). Willow Flycatcher nest sites typically had greater and less variable canopy cover, less ground cover, canopy height, greater foliage density at both the shrub and subcanopy levels, greater foliage height diversity, more stems of shrubs, trees, and box elders; and fewer stems of cottonwood. Nest plots did not have significantly more willow stems than unused sites. Foliage density was significantly more patchy around nest sites than at unused sites. Nest sites were significantly closer to water, on average, than unused sites (Table 2).

Table 2. Univariate comparisons between Willow Flycatcher nest sites and unused sites of continuous habitat variables. Boldface values indicate differences are significant (p<0.05).

Variable	Nest sites (n = 127)	Unused sites (n = 89)	Test statistic[a]	df	p
Average ground cover (%)	30.0 ± 23.4	39.2 ± 19.3	t = 3.17	208.4	**0.002**
C.V. ground cover	0.99 ± 0.49	0.74 ± 0.42	t = 1.28[b]	214	0.20
Average canopy cover (%)	88.7 ± 7.9	78.8 ± 12.4	U = 2641.0		**<0.001**
C.V. canopy cover	0.11 ± 0.11	0.22 ± 0.16	U = 4952.0		**<0.001**
Ave. canopy height (m)	13.9 ± 4.7	17.4 ± 9.7	t = -0.22[b]	150.5	0.83
C.V. canopy height	0.31 ± 0.15	0.38 ± 0.25	t = 2.46	135.5	**0.015**
Foliage density 1-3 m	11.4 ± 12.6	13.8 ± 6.3	t = 2.87	214	**0.005**
Foliage density 3-10 m	41.7 ± 12.6	25.9 ± 13.7	t = -8.76	214	**<0.001**
Foliage height diversity	1.48 ± 0.16	1.14 ± 0.21	t = -2.42	157.9	**0.017**
Foliage density patchiness	1.34 ± 0.05	1.29 ± 0.13	U = 3573.0		**0.001**
Total of shrub stems (< 10 cm)	29.3 ± 44.5	19.7 ± 25.6	U = 5535.0		**0.009**
Total of tree stems (≥10 cm)	9.8 ± 4.7	5.8 ± 3.6	t = -4.69[b]	146.1	**<0.001**
Total of box elder trees	6.0 ± 4.1	1.6 ± 2.6	t = -6.10[b]	214	**<0.001**
Total of willow stems	9.9 ± 37.9	3.7 ± 8.0	U = 8023.0		0.61
Total of cottonwood stems	0.48 ± 1.74	1.61 ± 3.40	U = 6911.0		**0.002**
Plant species diversity	0.60 ± 0.47	0.68 ± 0.47	t = 1.26	214	0.21
No. of woody plant species	2.98 ± 1.71	2.92 ± 1.52	t = -0.28	214	0.78
Distance to nearest water (m)	41.2 ± 53.8	63.0 ± 58.9	t = 2.83	214	**0.005**
Distance to nearest edge	9.9 ± 8.6	9.7 ± 7.0	t = -0.18	423	0.86

[a] t-tests when data met assumptions of normality, Mann-Whitney U-Tests when data could not be normalized.
[b] t-test performed on values transformed to meet assumptions of normality.

significant preference for box elders and avoiding willows. Again, flycatchers tended to nest very high. When data from other nesting sites in the Southwest are compared with data from other subspecies, it appears that *E. t. extimus* is consistently more arboreal in its nesting habits than are other subspecies. This apparent trend may be explained by availability of nesting substrates, if woodland riparian areas in the Southwest provide more suitable habitat than do shrubby sites. Alternatively, nest placement may be influenced by microclimatic considerations: in the arid Southwest, high nests may provide more suitable temperature or humidity conditions for nesting than may be available in lower, shrubby vegetation.

Comparisons of flycatcher nest sites with unused sites within occupied habitat patches revealed differences among almost all habitat variables examined. Notably, foliage density in the shrub layer (0-3 m) tended to be lower around nest sites than around unused sites. The most important of these, as indicated by a logistic regression, were canopy cover, number of box elder trees, and foliage density in the subcanopy. Comparisons of flycatcher numbers and nest success among habitat patches on the U Bar revealed no negative impacts of grazing on flycatchers, and positive impacts of ditch irrigation.

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Used sites also differed from unused sites in the presence or absence of certain species of common understory herbaceous plants. Nest points were significantly more likely than unused points to have wetland forbs such as spearmint (*Mentha spicata*; $\chi^2 = 4.4$, df = 1, $P = 0.03$) and nettles (*Urtica dioica*; $\chi^2 = 9.0$, df = 1, $P = 0.003$). In contrast, unused points were significantly more likely to have horehound (*Marrubium vulgare*; $\chi^2 = 5.3$, df = 1, $P = 0.02$), four o'clocks (*Mirabilis* spp.; $\chi^2 = 16.8$, df = 1, $P < 0.001$), jimsonweed (*Datura wrightii*; $\chi^2 = 6.0$, df = 1, $P = 0.02$) and morning glories (*Convolvulus* spp.; $\chi^2 = 28.4$, df = 1, $P < 0.001$), all plants typical of dry soils and/or edges.

Habitat variables found to differ significantly in univariate comparisons between nest and unused plots were included in a logistic regression model. When pairs of variables were significantly correlated (at $r > 0.5$, $P < 0.05$), we included the one variable we felt was more biologically meaningful. The logistic regression model (Table 3) with greatest predictive power identified foliage density in the subcanopy, number of box elder stems, and canopy cover as the best predictors of Willow Flycatcher use within occupied patches. The model correctly classified 88% of the nest plots, 81% of the unused plots, and 85% of all plots.

Table 3. Habitat variables found to be significant ($p < 0.05$) predictors of Willow Flycatcher use in a logistic regression analysis.

Variable	β	df	S.E.	Wald χ^2	P
Foliage density 3-10 m	1	0.08	0.018	17.42	< 0.001
No. box elder tree stems	1	0.33	0.070	22.06	< 0.001
Ave. canopy cover	1	0.08	0.025	10.71	0.001
Constant	1	-12.39	2.45	25.59	< 0.001

FUTURE PROJECT GOALS

In 2000, we intend to focus increasingly on characterizing Willow Flycatcher habitat at larger spatial scales. That is, we will determine which attributes of habitat patches and landscapes influence flycatcher presence and nesting success. We will also continue to band birds and begin to analyze patterns of within-site movement, site fidelity, and survival. Preliminary reports from small, mostly ephemeral populations in Arizona suggest relatively low levels of site and even mate fidelity (Paxton et al. 1997). Our limited observations of banded individuals on the U Bar suggest this may not be true in prime habitat.

CONCLUSIONS

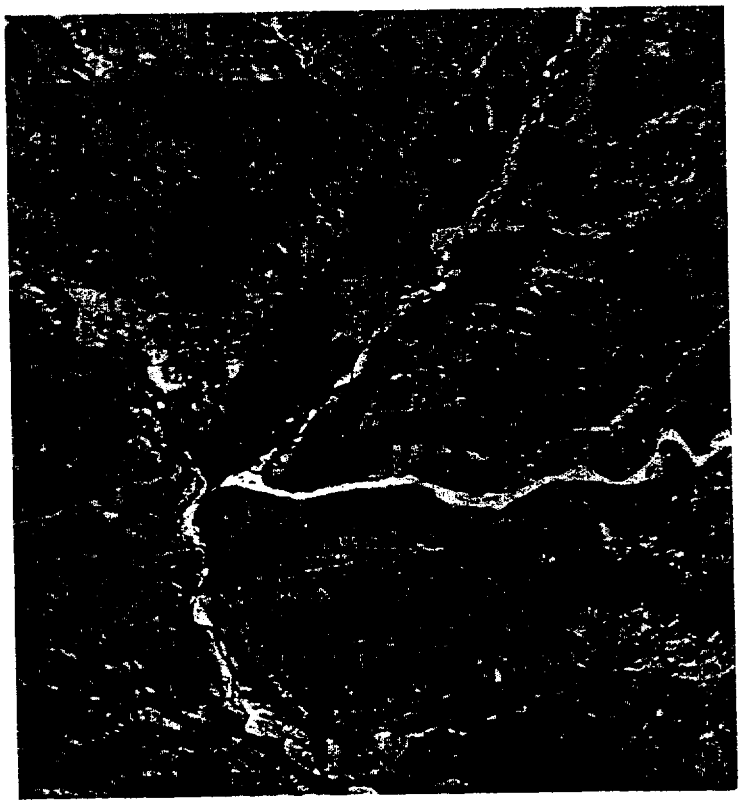
Willow Flycatchers in the Cliff-Gila Valley exhibited relatively poor nest success in 1999, perhaps due at least in part to the severe weather extremes experienced during the breeding season. Estimated rates of cowbird parasitism were the lowest we have found in three years (15.6%). Nest site selection was similar to that in 1997-98, with flycatchers demonstrating a significant preference for box elders and avoiding willows. Again, flycatchers tended to nest very high. When data from other nesting sites in the Southwest are compared with data from

ATTACHMENT "C"

SOUTHWESTERN WILLOW FLYCATCHERS IN THE CLIFF-GILA VALLEY, NEW MEXICO:

LANDSCAPE-LEVEL EFFECTS ON DENSITY, REPRODUCTION, AND COWBIRD PARASITISM

Draft Summary Report for the 2000 Field Season



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Executive Summary

The year 2000 was an odd one for Willow Flycatchers in the Cliff-Gila Valley. The population dropped substantially in size, yet reproductive output was at an all-time high. Surveys indicated the population declined over 40%, to 131 territories in the Valley. Similar levels of declines were noted elsewhere in the Southwest, suggesting a range-wide decline. Such a decline may have been due, at least in part, to a continuation of the severe drought begun in 1999. The total amount of precipitation that fell at Cliff, NM, between September of 1999 and May of 2000 was 2.88 inches, or only 34% of the norm for that period. The drought impacted the river levels, ditch flows, soil moisture, and vegetation. The drought was not confined to the Southwestern United States, but extended south through most of the flycatchers' winter range as well.

Despite the decline in population, flycatchers in the Cliff-Gila Valley had a tremendous year for reproduction. They achieved their highest rates of nesting success in 2000 in the four years of monitoring – overall, 67% of nests fledged one or more young. Cowbird parasitism reached its lowest level as well (11.5%). In addition, clutch sizes, in those nests where it could be determined, were larger than normal, with most first clutches having four eggs. Many pairs had second broods. We suggest that because of the low population numbers, most flycatchers were able to occupy the highest quality territories, which contributed to the high overall breeding success. Perhaps related to this explanation is the fact that a higher than normal percentage of nests was placed in box elder, the preferred nesting substrate in this population.

In 2000, we began in-depth analyses of patch and landscape-level effects (including land use) on flycatcher occurrence, nesting success, and cowbird parasitism. Results emphasized the importance of box elder to this population. The proportion of trees within a patch that were box elder had significant positive effects on the occurrence and density of flycatchers within patches. Further, the higher the proportion of box elder in a patch, the lower the average parasitism rate with the patch. Patch size, which has been demonstrated to have very profound effects on eastern forest birds, was positively correlated with patch occupancy – the larger the patch, the more likely that flycatchers bred in the patch – but also positively correlated with brood parasitism. Average rates of nest success within a patch were related to the maturity and density of its riparian woodlands. Although grazing has been labeled as a major causal factor for the decline and endangerment of the southwestern Willow Flycatcher, we found no significant negative impact of grazing on flycatcher nest success or brood parasitism in this system. In fact, patches that were grazed had a higher likelihood of patch occupancy and higher densities of flycatchers than ungrazed patches.

INTRODUCTION

In the past decade, avian ecologists increasingly have focused on ecosystem processes and patterns at spatial scales larger than the nest site or territory, such as the patch or landscape scale (Freemark et al. 1995). In particular, declines in Neotropical bird species have been linked to changes in landscape characteristics (Robinson et al. 1995, Askins 1995). Almost all of this work has been conducted in the eastern half of North America, where a majority of the avifauna is adapted to forest interior conditions. There, forest fragmentation has caused these forest interior bird species to increasingly overlap with predators and brood parasites typical of open areas and edges, often with disastrous consequences (Paton 1994, Danielson et al. 1997). This is the so-called edge effect. Moreover, these effects decrease with distance from edge, such that larger patches provide better habitat than smaller ones.

In contrast, in the western parts of North America, contiguous closed-canopy forest is uncommon, being found primarily in high-elevation montane areas. Much of the region supports non-forested habitats such as grasslands, shrublands, and desert. Within these non-forested habitats, riparian systems occur as narrow, linear corridors of close-canopied woodland, which support a rich and distinct avian community (Knopf et al. 1988). In the Southwest, riparian ecosystems have been severely degraded and fragmented by as much as 90% (Knopf et al. 1988). However, these riparian systems are highly dynamic in nature, resulting in a natural pattern of fragmentation (Szaro 1989). It remains unknown if the negative impacts of forest fragmentation and edge effects so well documented in the East are equally prevalent in these lower-elevation western habitats. One study in Montana suggests not (Tewksbury et al. 1998).

The Southwestern race of the Willow Flycatcher (*Empidonax traillii extimus*) is a critically endangered Neotropical migrant bird that breeds exclusively in densely vegetated riparian areas in the region. Approximately 600 pairs were known to exist in 1999, with more than a third of those in the upper Gila River Valley in New Mexico (Marshall 2000). It is currently considered the top priority species for US Fish and Wildlife Service Region 2. Within its range, many apparently suitable habitat patches (based on vegetation composition and structure) remain unoccupied. Among occupied patches, rates of nesting success and cowbird parasitism vary greatly. While several studies have now examined nesting success, parasitism, and microhabitat preferences within a single site (e.g., Sogge et al. 1997a, Stoleson and Finch 1999a, Paradzick et al. 2000), none has addressed landscape-level effects on habitat occupation and nesting success. Such landscape-level effects on the flycatcher have been identified as a top research priority (Stoleson et al. 2000).

The Cliff-Gila Valley population. – By far the largest known breeding concentration of Southwestern Willow Flycatchers is located in the Cliff-Gila Valley, Grant County, New Mexico. This population was estimated at 243 pairs in 1999 (P. Boucher, personal communication), and had increased every year since surveys began in 1994. These birds are located primarily on private property owned by the Pacific Western Land Company, a subsidiary of Phelps Dodge Corporation, and managed by the U Bar Ranch. Additional pairs occur on the adjacent Gila National Forest and other private holdings. Habitat preferences of flycatchers in this population differ, at least superficially, from those reported elsewhere (Hull and Parker 1995, Skaggs 1996, Stoleson and Finch 1999b), and from populations of other subspecies.

Objectives

Our goals for this study in 2000 were:

1. survey for flycatchers following standardized protocols to estimate population sizes in the Cliff-Gila Valley.
2. locate and monitor nests of Willow Flycatchers to assess levels of nesting success, cowbird parasitism and predation.
3. characterize and quantify vegetation at nests sites, territories, and unused sites within occupied habitat patches.
4. band adult and nestling Willow Flycatchers to allow individual identification.

This report presents the results of the fourth year of the study.

Methods

Study area. — The Cliff-Gila Valley of Grant County, NM, comprises a broad floodplain of the Gila River, beginning near its confluence with Mogollon Creek and extending south-southwest toward the Burro Mountains. The study was primarily conducted from just below the US Route 180 bridge upstream to the north end of the U-Bar Ranch (approximately 5 km). In addition, flycatchers were studied in two disjunct sections of the valley: (1) the Fort West Ditch site of the Gila National Forest and adjacent holdings of The Nature Conservancy's Gila Riparian Preserve, located about 9 km upstream of the Route 180 bridge, and (2) the Gila Bird Area, a riparian restoration project comprising lands of the Gila National Forest and Pacific-Western Land Company, located some 8 km downstream of the Route 180 bridge. Most of the Cliff-Gila Valley consists of irrigated and non-irrigated pastures used for livestock production and hay farming. Elevations range from 1350 to 1420 m.

The Gila River and nearby earthen irrigation ditches are lined with riparian woodland patches of various ages and composition. Most patches support a mature woodland (>25 m canopy) of Fremont cottonwood (*Populus fremontii*), with a subcanopy of mixed deciduous trees including box elder (*Acer negundo*), Goodding's willow *(Salix gooddingii*), velvet ash (*Fraxinus velutinus*), Arizona walnut (*Juglans major*), Arizona sycamore (*Platanus wrightii*), Arizona alder (*Alnus oblongifolia*) and Russian olive (*Elaeagnus angustifolia*). The understory is composed of shrubs including three-leaf sumac (*Rhus trilobata*), false indigo (*Amorpha fruticosa*), New Mexico olive *(Forestieria neomexicana*), forbs, and grasses. Fewer patches support a shrubby, early successional growth of seepwillow (*Baccharis glutinosa*), coyote and bluestem willows (*Salix exigua* and *S. irrorata*), and saplings of the species mentioned above. Most habitat patches are less than 5 ha in area. The FS Fort West Ditch site and the Gila Bird Area are generally more open than patches on the U-Bar. In addition to the primary patches of riparian woodland along the Gila itself, numerous stringers of riparian vegetation extend along many of the earthen irrigation ditches. These stringers contain the same plant species as larger forest patches, but rarely exceed 10 m in width.

Surveys. – All riparian habitats within each site were surveyed systematically for Willow Flycatchers using standardized survey techniques developed by the USFWS (Sogge et al. 1997a). Three surveys were conducted at each site during the periods of 15-30 May, 1-21 June, 22 June-15 July. Survey procedures entailed two observers walking through or adjacent to riparian habitat on clear, calm days between dawn and noon. Recordings of Willow Flycatcher vocalizations were played periodically to elicit responses from territorial birds. We recorded data on numbers of flycatchers, evidence of breeding by flycatchers, and presence of brown-headed cowbirds. All personnel of the Rocky Mountain Research Station held valid state and federal permits required for surveying and monitoring Southwestern Willow Flycatchers, and attended a mandatory survey protocol training session before initiating fieldwork.

Nest monitoring. – We searched for nests of Willow Flycatchers and other species on a daily basis. Nests were monitored every 3-7 days, following a modified (less-intrusive) version of protocols proposed by the Arizona Game and Fish Department (Rourke et al. 1999). Nest contents were observed using pole-mounted mirrors or videocameras, or 15X spotting scopes. Nests that were abandoned or destroyed were examined for evidence (e.g., cowbird eggs, mammal hairs) to ascertain causes of nest failure. We considered a nest successful if: (1) parent birds were observed feeding one or more fledged young; (2) parent birds behaved as if dependent young were nearby when the nest was empty (defensive or agitated behavior near nest); or (3) nestlings were in the nest within one or two days of the estimated fledge date. We considered a nest failed if: (1) nest contents disappeared before fledging of young was possible, assuming 10-12 d required for fledging (depredation), (2) the nest contained no Willow Flycatcher young but contained cowbird eggs or chicks (parasitized), (3) the nest was deserted after eggs had been laid (desertion), or (4) the nest was abandoned prior to egg laying (abandonment).

Vegetation and landscape measurements. – We identified and included in our analyses 39 discrete woodland patches in the Cliff-Gila Valley. We limited our focus to those patches that might be considered potential flycatcher habitat according to published descriptions (Stoleson and Finch 1999a, b; Sogge and Marshall 2000). Patches included were (1) well within the floodplain and so mesic enough to qualify as habitat, (2) wide enough (>10 m average width), and (3) of sufficient age and stature to provide adequate structure. We did not include any of the numerous very small (< 0.3 ha) patches or young regeneration of coyote willow and seepwillow, as flycatchers in this area do not appear to use them regardless of landscape features (Stoleson and Finch, unpublished data).

Within each patch, vegetation was sampled systematically starting from a randomly chosen point, using a modified BBIRD methodology (Martin et al. 1997). Sampling points were established spaced 50 to 100 m apart and at least 10 m from habitat edges. The number of sample points per patch varied with patch size and shape. Vegetation characteristics measured at each point included stem counts for trees (within 8 m of point) and shrubs (within 4 m of point) by size class and species; basal area by species; average canopy height, and canopy cover. Canopy cover was measured using hemispherical densiometers; sample point values were the average measurements at the sample point and at 4 and 8 m in reach of the cardinal directions from the sample point. Canopy heights were measured using hand-held clinometers. For each vegetation variable, we calculated patch averages and standard deviations (as a measure of homogeneity within patches).

Locations and dimensions of riparian patches were calculated using a combination of GPS (Global Positioning System) measurements and photointerpretation of digitized aerial photos provided by the Gila National Forest. This area turned out to be one of the very few remaining in the country without registered digital orthoquads yet available; therefore, we were obliged to acquire basic spatial data in the field. For each riparian patch, we determined patch area (ha), average and minimum patch width (m), patch length (m; parallel to river course), proximity to water (m), proximity to river (m), proximity to nearest patch (m), proximity to nearest occupied patch (m), proximity to nearest roads (m), width of floodplain (m, perpendicular to river course), and proximity to nearest upland. From these values, we calculated ratios of length to width, and perimeter to area, as measures of proportion of edge (Freemark et al. 1995). Because of the controversy and lack of objective information on the impacts of grazing on Willow Flycatchers, we attempted to assess such impacts, if any, at the landscape and patch level in the Gila Valley. We determined the grazing status of each patch, which was entered into analyses as a categorical variable (grazed vs. ungrazed). Numerical variables used in subsequent analyses are listed in Table 1.

Analyses

We used nesting data from 1997-2000 to calculate patch-wise averages of flycatcher nesting success and rates of cowbird parasitism. Flycatcher population levels fluctuated among years, but proportions of the total found within each patch remained approximately constant each year. For analyses, we therefore used density estimates based on 1999 data only, as data from 2000 had not yet been collated. All means are reported $\pm$ standard deviations.

Correlates of patch occupancy. – To assess landscape correlates of patch occupancy, we first compared occupied and unoccupied patches for each numerical variable using univariate t-tests. We included all numerical and categorical landscape variables that differed significantly (at $p <$ 0.10) between occupied and unoccupied patches in a step-wise logistic regression using patch occupancy (occupied vs. unoccupied) as the dependent variable (Trexler and Travis 1993). We used a value of $p \leq 0.05$ to enter and 0.10 to remove individual variables from the model. We chose the most parsimonious among models with equal numbers of parameters using Akaike's Information Criterion (AIC), and we used Likelihood-ratio Chi-square to test for significant effects between nested logistic regression models (Anderson et al. 2000).

Table 1. Numerical landscape and habitat variables used in analyses

VARIABLE	DESCRIPTION
Patch size/shape	
AREA	Total area of patch, in hectares
LENGTH	Length of patch along axis parallel to river, in meters
AVEWIDTH	Average width of patch along axis perpendicular to river, in meters
LENGTH/WIDTH	Ratio of patch length to width
PERIMETER/AREA	Ratio of patch perimeter to area
Patch vegetation characteristics	
CANCVRave	Average % canopy cover in patch
CANCVRsd	Standard deviation of % canopy cover among sample points in patch
CANHTave	Average canopy height in patch, in meters
CANHTsd	Standard deviation of canopy heights among sample points in patch
SHRUBave	Average number of stems of shrubs and saplings per sample point
SHRUBsd	Standard deviation of shrub counts among sample points in patch
TREESave	Average number of stems of trees ($\geq$10 cm dia.) per sample point
TREESsd	Standard deviation of tree counts among sample points in patch
Stems10-30	Average count of trees in 10 – 30 cm dia. size class per sample point
Stems30-50	Average count of trees in 30 – 50 cm dia. size class per sample point
Stems50-70	Average count of trees in 50 – 70 cm dia. size class per sample point
Stems70+	Average count of trees in 70+ cm dia. size class per sample point
%BOX	Percentage of woody stems in patch that are boxelder (*Acer negundo*)
%SALIX	Percentage of woody stems in patch that are willow (*Salix* spp.)
BASALAREAave	Average estimated basal area per sample point, in square meters
BASALAREAsd	Standard deviation of est. basal area among sample points in patch
Patch position in landscape	
DistH20	Minimum distance to nearest water of any type. in meters
DistRIVER	Minimum distance to surface water of Gila River, in meters
DistNEAREST	Minimum distance to next nearest patch, in meters
DistOCCUP	Minimum distance to nearest patch occupied by flycatchers, in meters
FLOODPLAIN	Distance across floodplain perpendicular to flow of river, as measured at midpoint of patch, in meters
UPLAND	Minimum distance to closest upland/floodplain interface, in meters
DistROAD	Minimum distance to nearest road, in meters

Correlates of flycatcher density, nest success, and brood parasitism. -- We determined the correlation of each numerical landscape variable to the target variable using bivariate linear regressions. All numerical landscape variables that differed significantly (at $p < 0.10$) were included in a step-wise multiple regression, using $p \leq 0.05$ to enter and 0.10 to remove. We also compared the means of target variables between grazed and ungrazed patches using t-tests to assess any impacts of grazing as practiced at this site. We tested whether nest success and brood parasitism were density dependent by regressing the target variable against population density within a patch.

RESULTS

Climate in 2000. – The drought that impacted the Cliff-Gila Valley in 1999 continued through the entire 2000 field season. The annual rainfall total for 1999 as measured in Cliff, NM, was 10.75 inches – only 74% of normal. However, the drought worsened after the 1999 field season. The total amount of precipitation that fell from the time the flycatchers left for their wintering grounds (1 Sept., 1999) until they returned to set up territories (1 June, 2000) was 2.88 inches, or only 34% of the norm for that period (ave. = 8.46 in). Thus, the Cliff-Gila Valley was extremely dry when the flycatchers returned to set up territories in late May. Water in the irrigation ditches was low, intermittent, or nonexistent. In the upper parts of the Valley (Fort West Ditch area), many of the cottonwoods and willows dropped their leaves, and some trees died.

Table 2. Precipitation at Cliff, New Mexico, for 1999, 2000, and annual averages for 1936-1999. Data from the Western Regional Climate Center (2000).

	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sep.	Oct.	Nov.	Dec.	TOTAL
1999 precip.	0.11	0	0.35	0.39	0.08	0.93	5.09	1.88	1.85	0	0	0.07	10.75
2000 precip.	0.06	0.07	0.8	0.03	0	2.19	1.63	N/A	N/A	N/A	N/A	N/A	N/A
Average (1936-99).	1.00	0.94	0.86	0.33	0.35	0.53	2.77	2.84	1.65	1.28	0.71	1.16	14.52
2000: % of normal	6.0	7.4	93.0	9.1	0.0	413	58.8						
2000: cumulative (in.) deviation from norm since Jan '99	-4.6	-5.5	-5.5	-5.8	-6.2	-4.5	-5.7						

This extended drought was not confined to southwestern New Mexico, or even the southwestern United States. During the period 1999 – summer 2000, precipitation was well below normal throughout the Pacific slope of Mexico and Central America, at least as far south as Costa Rica. For example, precipitation at the northern end of the flycatchers' wintering grounds in Guerrero, Mexico, was 44% below normal for the period Jan. – Aug. of 2000 (SNM 2000; Fig. 1). For the same period, precipitation at Liberia, Costa Rica, in the center of the wintering grounds, was 35% below normal levels (INM 2000). Thus, it appears that the entire subspecies was subject to extensive drought on both the breeding and wintering grounds in 1999-2000.

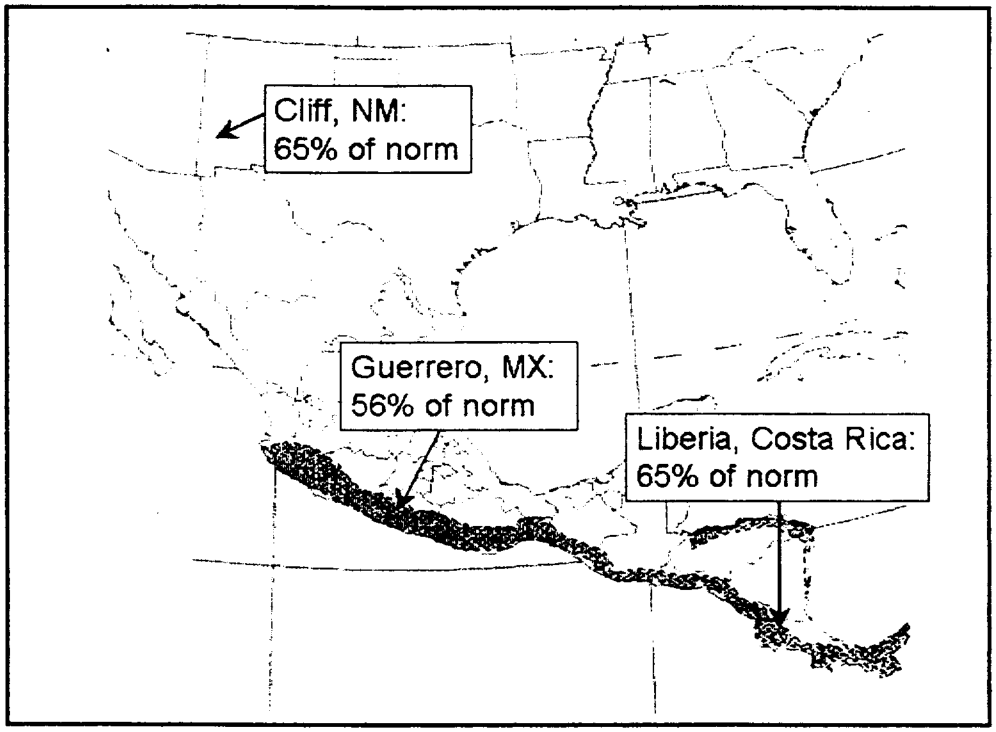

Figure 1. Proportion of normal precipitation from Jan. to Aug. 2000 at Willow Flycatcher breeding grounds (Cliff) and two sites on the wintering grounds, showing the wide area affected by drought. Shaded area indicates flycatcher wintering areas (from Howell & Webb 1997). Cliff climate data from WRCC 2000.

Willow Flycatcher population surveys. – The population of Willow Flycatchers in the Cliff-Gila Valley declined substantially in 2000, from an estimated 243 pairs in 1999 to 139 pairs (Fig. 2). This represents a drop of 43%. On the U Bar Ranch itself, the numbers declined from 209 to 121 pairs, a decrease of 42% (Appendix). The birds appeared to have left the more peripheral and marginal areas of the valley, but remained relatively common in the core areas of prime habitat.

Oddly, in 2000, we noted the first instance of flycatchers occupying a patch we refer to here as SW Crescent – a small crescent-shaped patch of young regeneration just northwest of the Rt. 180 bridge. This patch has been surveyed every year since 1997, but has not been included in reports because no flycatchers had ever been detected. This colonization suggests that birds probably shifted around within the valley in 2000. Flycatcher numbers declined greatly in some patches dependent on irrigation ditches for water. For example, on the SW Stringer, we found 3 pairs plus two apparently single males in 2000, compared to 14 pairs in 1999. In contrast, other more low-lying patches (such as SE4) had their highest numbers ever in 2000 (6 pairs vs. 3-5 in previous years). Declines upstream on the Fort West Ditch and TNC properties were even more marked than on the U Bar Ranch.

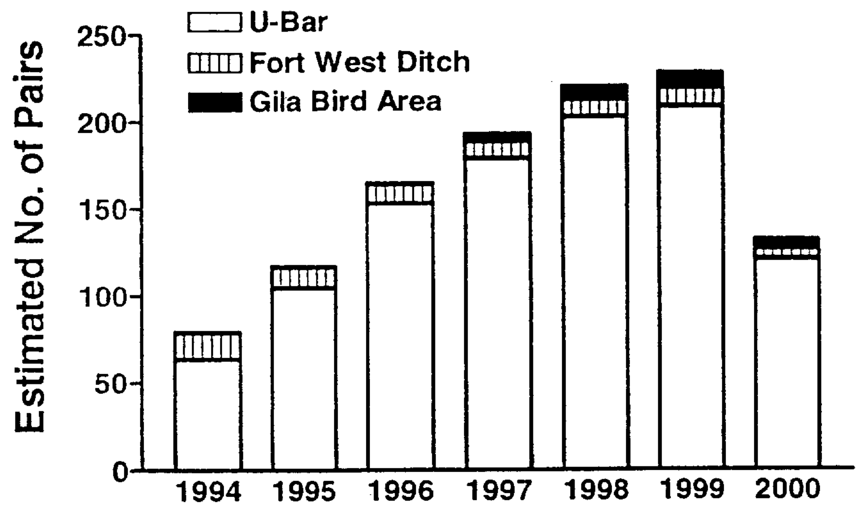

Figure 2. Population estimates of Willow Flycatchers in the Cliff-Gila Valley, 1994-2000.

Flycatcher nests. – We located 85 Willow Flycatcher nests in 2000. Of these, 71 (84%) were placed in box elder – a somewhat higher percentage than the 70% to 75% found in box elder in all previous years. A much lower percentage was found in willows (n = 3, or 3.5%) compared to previous years (average of 11.9%, n = 48). Relatively few were found in other tree species (Table 3). This concentration in box elder, the favorite nesting substrate, again suggests the flycatchers retreated to preferred areas in this very dry year.

As in previous years, Willow Flycatchers nested high in the Cliff-Gila Valley. Nest heights ranged from 1.8 to 24.1 m in height, with a mean height of 7.8 ± 3.5 m (Table 3). Trees and shrubs in which flycatchers built nests averaged 13.7 ± 4.9 m, and ranged from 2.7 to 30.1 m high. As with height, nest trees varied greatly in diameter, from 1.2 cm in alder to a huge 142.5 cm cottonwood (mean = 24.5 ± 19.8 cm). The nest located in that large cottonwood represents a new record for nest height for the species (24.1 m = 78.3 ft).

Table 3. Nest substrates, nest heights, and comparative nest success by substrate (based on nests of known outcome) for Willow Flycatcher nests in the Cliff-Gila Valley, 2000.

Nest Substrate	N	Mean nest ht. (m)	Range nest ht. (m)	% successful (N)
Box elder	71	8.2 ± 3.1	1.8 – 16.0	69% (52)
Fremont cottonwood	5	9.8 ± 7.7	4.0 – 24.1	100% (3)
Goodding's willow	3	4.0 ± 1.0	3.3 – 5.5	0% (3)
Russian olive	2	4.9	3.8 – 6.0	50% (2)
Arizona alder	2	2.7	2.3 – 3.0	0% (2)
Saltcedar	2	3.0	2.8 – 3.1	100% (2)

Willow Flycatcher nest success. – Despite the decline in population, flycatchers in the Cliff-Gila Valley enjoyed very high rates of nesting success in 2000. Overall, 67% of nests fledged one or more young – this is one of the highest rates of nest success recorded for this species; other sites with >60% nest success have had extensive cowbird trapping and other forms of intensive management (e.g., San Luis Rey, CA). Simple nest success gives only a partial picture of the breeding effort, though. Many pairs raised a second brood after successfully fledging their first. Clutch sizes appeared to be larger than in prior years, with most first nests containing four eggs (vs. a mean of 3.2 in prior years). One pair also had a second clutch of four eggs, and successfully raised a total of eight young from their two nests (in saltcedar). In addition to the 85 nests that were found, we found fledglings being fed in four territories where no nest was found. A minimum of 65 fledglings was produced from flycatcher nests on the U Bar, although the actual number was probably two or more times that amount.

As in previous years, the likelihood of a nest being successful appeared to vary among nest tree species, although small sample sizes for most species preclude statistical analysis. Nests in box elder were slightly more likely to be successful than average (Table 3). All nests in cottonwood and saltcedar fledged young, while no nest in willow or alder fledged any young in 2000.

Causes of nest failure. – Of the 21 nests known to have failed, eight failed due to unknown causes (although these were probably depredated). One failed due to weather (blown out of tree during a storm). The remainder failed due to predators (n = 4), abandonment (n = 4), or cowbird parasitism (n = 4). One nest in alder was parasitized by cowbirds, but was lost to a predator before the cowbird egg had hatched.

Cowbird parasitism. – Of 52 nests for which parasitism status was known. we found six flycatcher nests that had been parasitized by Brown-headed Cowbirds (11.5%). In at least one of those, the cowbird egg failed to hatch and flycatcher young were successfully produced. Unlike previous years, we found no cowbird fledgling being fed for which no nest was ever found. This is by far the lowest level of parasitism we have recorded in four years of study, and may be related to the suggestion that flycatchers nested primarily in optimal areas this year.

Landscape-Level Analyses

Patch descriptions. – We included 39 woodland patches in landscape analyses, which ranged from 0.38 to 11.8 ha in size. Most of the patches were located on the U Bar Ranch; many of these patches had cattle excluded by fences. Overall, 18 of 39 patches were grazed, primarily in fall and winter only. Of the 39 study patches, 27 supported breeding Willow Flycatchers in 1999. Flycatcher densities varied greatly among occupied patches, and ranged from 0.25 to 10.3 pairs/ha. Average nest success within patches (from nests monitored 1997- 2000) also varied greatly, from 0% to 100% successful (mean = 0.51 $\pm$ 0.24, n = 392 nests of known outcome). Brood parasitism within occupied patches varied from 0% to 100%, with a mean of 19.9 $\pm$ 29.9% (n = 222 nests of known parasitism status). Patches with very high or very low rates for either parameter had very small sample sizes (< 5) of flycatcher nests.

Landscape Correlates of Flycatcher Occupancy

Land use. – We found no evidence that grazing within a patch discouraged flycatchers from occupying that patch. In fact, flycatchers were found in a significantly greater portion of the grazed patches than the ungrazed patches (87.5 vs. 52.4%, respectively; $\chi^2 = 6.5$, df = 1, p = 0.011).

Univariate regressions. – We compared each landscape variable between patches that were occupied and those that were unoccupied by Willow Flycatchers. Six variables differed significantly ($p \leq 0.05$) between occupied and unoccupied patches (Table 4). Patches with flycatchers averaged larger in area, greater in length, had lower variation in the numbers of shrubs, a higher percentage of box elder, were closer to water, and closer to the next nearest

Table 4. Comparisons of landscape variables between patches occupied (n = 27) and not occupied (n = 12) by Willow Flycatchers. Significant p values ($\leq$ 0.05) are indicated in bold.

	Mean ± SD				
Variable	occupied	unoccupied	t	df	p
AREA (ha)	4.30 ± 2.77	2.07 ± 1.36	-3.38	36.5	**0.002**
LENGTH (m)	507.71 ± 300.17	346.52 ± 134.49	-2.32	36.97	**0.026**
AVEWIDTH (m)	75.08 ± 43.34	70.39 ± 35.90	-0.33	37	0.75
LENGTH/WIDTH	8.16 ± 6.27	5.62 ± 2.43	-1.82	36.64	0.077
PERIMETER/AREA	355.41 ± 224.32	501.91 ± 220.91	1.77	35	0.085
CANCVRave (%)	83.59 ± 8.99	77.13 ± 19.20	-0.97	9.25	0.36
CANCVRsd	8.56 ± 3.89	14.32 ± 12.43	1.37	8.57	0.21
CANHTave (m)	14.98 ± 4.71	15.22 ± 7.58	0.12	36	0.91
CANHTsd	6.13 ± 3.06	5.05 ± 2.66	-0.94	32	0.35
SHRUBave (count)	28.30 ± 12.93	29.53 ± 17.60	0.24	36	0.81
SHRUBsd	14.57 ± 5.92	20.34 ± 5.47	2.56	32	**0.016**
TREESave (count)	10.02 ± 4.72	12.22 ± 7.85	1.01	33	0.32
TREESsd	5.22 ± 2.85	5.83 ± 3.78	0.50	32	0.62
Stems10-30 (count)	8.25 ± 4.80	10.19 ± 7.69	0.89	33	0.41
Stems30-50 (count)	0.97 ± 0.55	1.21 ± 1.14	0.60	9.31	0.56
Stems50-70 (count)	0.30 ± 0.30	0.39 ± 0.60	0.44	9.41	0.67
Stems70+ (count)	0.49 ± 0.58	0.43 ± 0.69	-0.27	33	0.79
%BOX	41.47 ± 28.67	8.87 ± 17.06	-4.41	33.57	**>0.001**
%SALIX	24.75 ± 21.83	40.31 ± 25.19	1.96	37	0.058
BASALAREAave (m^2)	418.37 ± 169.41	494.04 ± 275.98	0.77	10.17	0.46
BASALAREAsd	224.13 ± 119.13	237.76 ± 97.91	0.31	32	0.76
DistH20 (m)	3.74 ± 8.57	26.11 ± 33.58	2.28	11.64	**0.043**
DistRIVER (m)	64.24 ± 103.12	41.62 ± 42.82	-0.97	36.94	0.34
DistNEAREST (m)	174.57 ± 223.50	332.09 ± 221.62	2.04	37	**0.049**
DistOCCUP (m)	323.76 ± 660.96	792.73 ± 1121.34	1.64	37	0.110
FLOODPLAIN (m)	4256.43 ± 1764.87	3003.07 ± 1873.63	-2.01	37	0.052
UPLAND (m)	1160.12 ± 797.67	896.28 ± 805.90	-0.95	37	0.348
DistROAD (m)	1212.50 ± 740.26	1149.81 ± 876.80	-0.23	37	0.819

patch, than were patches without flycatchers. An additional four variables showed trends towards differences between the two patch types ($0.05 < p \leq 0.10$). Occupied patches tended to have a greater length-to-width ratio and a lower perimeter-to-area ratio, a *lower* percentage of woody stems that were willow, and a broader floodplain than unoccupied patches.

Logistic regression model. – We used six of the variables found to have significant or near-significant differences above in a logistic regression analysis. Since all of the variables describing patch size or shape were highly correlated with each other (all $r > 0.5, p < 0.05$), we used only AREA, with the greatest p-value, in our analysis to avoid problems associated with collinearity of variables.

The best logistic regression model, as determined by AIC, identified three variables as significant predictors of patch occupancy by Willow Flycatchers. These variables were percent of stems that were box elder (%BOX), the distance to the nearest patch (DistNEAREST), and the standard deviation of shrub counts (SHRUBsd). This model successfully classified 96.0% of occupied patches, 77.8% of unoccupied patches, and 91.2% of patches overall. The beta coefficients indicate that patches were increasingly more likely to be occupied with (1) increasing proportion of box elder, (2) decreasing distance to nearest patch, and (3) decreasing variation in the number of shrubs among points within the patch (Table 5).

Table 5. Landscape variables found to be significant ($p < 0.10$) predictors of patch occupancy by Southwestern Willow Flycatchers, based on a stepwise logistic regression.

Variable	β coefficient	S.E.	Wald χ^2	df	p
%BOX	0.211	0.123	2.951	1	0.086
DistNEAREST	-0.016	0.010	2.635	1	0.105
SHRUBSsd	-0.496	0.259	3.674	1	0.055
CONSTANT	9.190	4.558	4.066	1	0.044

Landscape Correlates of Flycatcher Density

Land use. – Grazing appeared to have a significant effect on flycatcher densities. Grazed patches supported significantly higher densities (2.51 ± 2.70 pairs/ ha) than did ungrazed patches (0.98 ± 1.94 pairs/ha: $t = 2.05$, df = 37, $p = 0.047$).

Bivariate correlations. – We found only one landscape variable, percent of box elder, was significantly correlated with flycatcher density. The density of flycatchers increased with increasing percentage of box elder within patches. A second variable, width of floodplain, showed a nearly significant positive correlation with density, suggesting that the broader the floodplain, the higher the density of flycatchers.

Mutiple regression analysis. – The stepwise multiple regression analysis also revealed only box elder to be a significant predictor of flycatcher density; density increased with increasing percentage of box elder ($r^2 = 0.14$, $F_{1,29} = 4.85$, $p = 0.036$). As indicated by the r^2 value, this variable explained less than 15% of the variation in density among patches. There seemed to be no significant interaction effects in this data set.

Landscape Correlates of Flycatcher Nest Success

Population density. – Average rates of nest success within patches were not correlated with the density of flycatchers within those patches ($r^2 = 0.002$, $p = 0.84$). Thus, nest success does not appear to be density-dependent in this population.

Land use. – We found no detectable impact of grazing on flycatcher nest success. Occupied patches that were grazed ($n = 15$) had a similar overall rate of nest success (0.56) as patches that were excluded from grazing (0.45; $n = 12$; $t = -1.1$, df = 25, $p = 0.28$).

Bivariate correlations. -- Six variables were significantly correlated with average patch-wise nest success. Average rates of nest success increased with decreasing variation in canopy cover, and with increasing average canopy cover, average canopy height, numbers of woody stems in the 30-50 cm DBH and 70+ cm DBH size classes, and with increasing distance from nearest occupied patch (Table 7). Two additional variables showed not-quite-significant trends: nest success increased with decreasing variation in tree counts, and with increasing percent of stems that were box elder.

Table 6. Bivariate correlations of landscape variables on average patch-wise density of Willow Flycatchers.

VARIABLE	Pearson r	P
AREA (ha)	0.023	0.89
LENGTH (m)	0.057	0.73
AVEWIDTH (m)	0.074	0.66
LENGTH/WIDTH	0.023	0.89
PERIMETER/AREA	0.010	0.95
CANCVRave (%)	0.069	0.69
CANCVRsd	0.093	0.60
CANHTave (m)	0.054	0.75
CANHTsd	0.098	0.58
SHRUBave (count)	0.11	0.52
SHRUBsd	0.089	0.62
TREESave (count)	0.16	0.37
TREESsd	0.092	0.61
Stems10-30 (count)	0.14	0.41
Stems30-50 (count)	0.042	0.81
Stems50-70 (count)	0.086	0.62
Stems70+ (count)	0.025	0.89
%BOX	0.44	**0.006**
%SALIX	0.19	0.24
BASALAREAave (m^2)	0.16	0.35
BASALAREAsd	0.13	0.48
DistH20 (m)	0.15	0.37
DistRIVER (m)	0.068	0.68
DistNEAREST (m)	0.25	0.12
DistOCCUP (m)	0.23	0.17
FLOODPLAIN (m)	0.28	0.080
UPLAND (m)	0.30	0.067
DistROAD (m)	0.071	0.67

Multiple regression analysis. – Five variables were found to be significant predictors of flycatcher nest success (Table 8). Oddly, only one variable identified as a significant predictor by the multiple regression analysis (CANCVRsd) showed a significant correlation with nest success in the univariate regression analyses. Nest success increased with increasing average basal area, and with decreasing width of floodplain, patch area, total number of stems in the 10-30 cm DBH size class, and variation in canopy cover. According to the multiple regression equation, these six variables explained 84% of the variation in nest success among patches ($r^2 = 0.84$, $F_{5,19} = 19.98$, $p < 0.001$).

Landscape Correlates of Brood Parasitism on Willow Flycatchers

Population density. – Average rates of brood parasitism within occupied patches were not correlated with the density of flycatchers within those patches ($r^2 = 0.002$, $p = 0.82$). Thus, brood parasitism does not appear to be density-dependent in this population.

Land use. – Brood parasitism within a patch was not significantly affected by grazing status of the patch. Average patch-wise parasitism rates did not differ between grazed (20.7 ± 29.3%) and ungrazed patches (18.8 + 31.9%; t = 0.16, df = 25, $p = 0.88$).

Bivariate correlations. – Two landscape variables related to patch dimensions were significantly and positively correlated with brood parasitism rates: patch area and average width (Table 9). The positive correlation coefficients indicate that with increasing patch size and width, brood parasitism rates increased. This result is opposite what would be expected if these riparian woodland patches showed an edge effect. An additional three variables showed not-quite-significant trends as well. Parasitism rates increased with the number of small stems (10-30cm DBH), but decreased with increasing stems in the 30-50 cm DBH size class and with the percentage of box elder.

Multiple regression analysis. – The average patch-wise rate of cowbird parasitism was best predicted by a single variable in a stepwise multiple regression analysis. The average parasitism rate decreased with increasing percentage of box elder (r^2 = 0.21, $F_{1,23} = 6.04$, $p = 0.022$). This model explained only about 20% of the variation in parasitism rates among patches.

Table 7. Bivariate correlations of landscape variables with average patch-wise nest success in Willow Flycatchers

VARIABLE	Pearson *r*	P
AREA (ha)	0.26	0.19
LENGTH (m)	0.18	0.36
AVEWIDTH (m)	0.17	0.41
LENGTH/WIDTH	0.10	0.61
PERIMETER/AREA	0.043	0.83
CANCVRave (%)	0.50	**0.010**
CANCVRsd	-0.56	**0.004**
CANHTave (m)	0.56	**0.003**
CANHTsd	0.33	0.10
SHRUBave (count)	0.27	0.19
SHRUBsd	0.28	0.18
TREESave (count)	0.059	0.78
TREESsd	-0.35	0.085
Stems10-30 (count)	-0.070	0.73
Stems30-50 (count)	0.46	**0.019**
Stems50-70 (count)	0.31	0.12
Stems70+ (count)	0.45	**0.023**
%BOX	0.37	0.057
%SALIX	-0.001	0.99
BASALAREAave (m^2)	0.28	0.17
BASALAREAsd	-0.031	0.89
DistH20 (m)	0.12	0.55
DistRIVER (m)	-0.22	0.27
DistNEAREST (m)	0.027	0.89
DistOCCUP (m)	0.39	**0.042**
FLOODPLAIN (m)	-0.062	0.76
UPLAND (m)	-0.062	0.76
DistROAD (m)	0.084	0.68

Table 8. Variables included in a linear stepwise multiple regression of landscape variables on Willow Flycatcher nest success.

Variable	Coefficient (β)	*t*	*p*
CANCOVRsd	-0.56	-5.46	<0.001
FLOODPLAIN	-0.50	-4.92	<0.001
AREA	-0.27	-2.83	0.011
TOT10-30	-0.15	-7.02	<0.001
ESTBAave	1.08	6.44	<0.001
CONSTANT	0.93	8.68	<0.001

Table 9. Bivariate correlations of landscape variables with average patch-wise rates of brood parasitism in Willow Flycatchers

VARIABLE	Pearson *r*	P
AREA (ha)	0.43	**0.027**
LENGTH (m)	0.14	0.49
AVEWIDTH (m)	0.41	**0.032**
LENGTH/WIDTH	-0.010	0.62
PERIMETER/AREA	0.021	0.92
CANCVRave (%)	-0.26	0.21
CANCVRsd	-0.11	0.61
CANHTave (m)	-0.30	0.14
CANHTsd	-0.24	0.24
SHRUBave (count)	0.14	0.50
SHRUBsd	-0.16	0.46
TREESave (count)	0.30	0.14
TREESsd	0.046	0.83
Stems10-30 (count)	0.38	0.053
Stems30-50 (count)	-0.36	0.069
Stems50-70 (count)	-0.31	0.12
Stems70+ (count)	-0.16	0.44
%BOX	-0.38	0.054
%SALIX	-0.13	0.54
BASALAREAave (m^2)	0.13	0.52
BASALAREAsd	-0.015	0.94
DistH20 (m)	0.12	0.54
DistRIVER (m)	0.11	0.60
DistNEAREST (m)	0.014	0.94
DistOCCUP (m)	-0.15	0.45
FLOODPLAIN (m)	0.11	0.59
UPLAND (m)	0.13	0.53
DistROAD (m)	0.037	0.85

DISCUSSION

The year 2000 was an odd one for Willow Flycatchers in the Cliff-Gila Valley. The population appeared to have dropped substantially in size, yet reproductive output was at an all-time high. The decline in population was likely due to the continued severe drought, not just in southwestern New Mexico, but extending south to the birds' wintering grounds in western Central America. It is noteworthy that population declines of approximately 40% were also reported from both the Kern River Preserve and Camp Pendleton in California (M. Whitfield, personal communication). This suggests a possible range-wide decline in numbers. It appears that populations of the entire subspecies may have been reduced because of extensive and prolonged drought on both the breeding and wintering grounds. Alternatively, populations may not have changed in size, but rather some birds might have never returned to their breeding grounds in 2000 because of drought-induced food shortages. No data exist to support this idea directly, although a study in Costa Rica during the winter and spring of 1999/2000 found most birds still present on territory in early May of 2000 (Koronkiewicz and Sogge 2000), at the same time that some birds had already arrived on the breeding grounds on the U-Bar (pers. observ).

In general, populations tend to expand into new areas when they are increasing, and often contract spatially when declining (Caughley 1977). In the Cliff-Gila Valley in 2000, we witnessed local contraction away from the peripheries of the population. Relatively fewer birds than in previous years nested in edge areas with willow, younger habitats, or along narrow stringers of vegetation. Most birds were concentrated in dense box elder stands, as reflected by the proportion of nests placed in that species.

The higher nest success we observed in 2000 may be an artifact of this apparent contraction. The birds nesting in these highest-quality areas may experience high nest success every year. In prior years, additional birds inhabiting marginal areas may have experienced poor nest success, thus diminishing the overall average success rate. Nest success has shown a strong and significant negative correlation with population size in the Cliff-Gila Valley from 1997 to 2000 (Fig. 3), which would lend credence to this hypothesis. Alternatively, some other density dependent factor may have influenced nest success, though what that factor may have been is unclear.

Factors affecting patch occupancy and flycatcher density. – Within the Cliff-Gila valley, habitat patches exhibited a range in density of Willow Flycatchers, including numerous patches with no birds at all. At a basic level, the birds occupied only the more mature, taller, and more structurally complex patches. We ignored the younger, simpler patches in our analyses. Among those older, more complex patches, flycatchers showed distinct preferences for larger, longer patches with a higher proportion of box elder, relatively lower variation in the density of shrubs, and those closer to water and to the next nearest patch. Most of these variables are partially correlated with each other. For example, box elder tends to be more frequent in patches closer to water. In part because of these correlations, a logistic regression model identified only three variables as significant predictors of patch occupancy: box elder, distance to the next nearest patch, and variation in shrubs. The model successfully categorized a higher percentage of occupied (96%) than unoccupied patches (78%). This may reflect the fact that occupied patches varied less in the various measurements than did unoccupied patches. It may also mean that some unoccupied patches (those incorrectly categorized as occupied) are in fact suitable for flycatchers, but have not yet been colonized. Thus, the area may not be fully saturated with flycatchers yet.

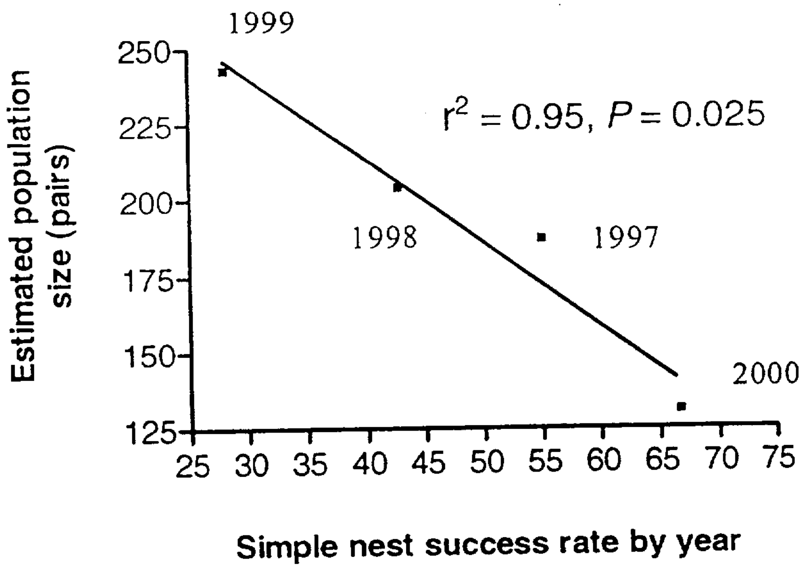

Figure 3. Flycatcher nest success has been strongly and negatively correlated with population size.

Previous studies of this population of flycatchers have shown that box elder is strongly preferred for nesting (Stoleson and Finch 1999a, b). Therefore, it seems logical that patches with an abundance of the preferred nesting tree would be more likely to have flycatchers than those without. The second variable, distance to nearest patch, suggests that flycatchers are more likely to colonize and occupy habitat patches that are near other habitat patches rather than isolated. Perhaps the likelihood of flycatchers dispersing among patches decreases with distance between patches, as has been shown with other birds (Greenwood and Harvey 1982). Finally, although occupied and unoccupied patches did not differ significantly in the average number of shrubs per sample point (Table 4), occupied patches had considerably less variation within the patch. This suggests that Willow Flycatchers tended to avoid the extremes of very dense undergrowth and very open understory. Although often thought of as a shrub-inhabiting bird, the flycatcher's weak feet and short legs make it unsuitable for hopping through dense thickets. At the other extreme, very open understories may provide inadequate cover from predators or substrates for insect prey.

Not only was the proportion of box elder a significant predictor of patch occupancy, but also it was the sole variable found to be significantly correlated with flycatcher density. This too can be attributed to the strong preference birds in this population show for nesting in box elder.

Factors affecting Willow Flycatcher nest success and brood parasitism – Assessing correlates of nest success based on a per-patch average is necessarily a coarse-level analysis for a variety of reasons. Habitat within patches may vary, as may the ability for observers to locate and monitor flycatcher nests. Most nest failures in this population result from predation (Stoleson and Finch 1999a). Therefore, any factors we identify as significant correlates of nest success may in fact be irrelevant to the flycatcher itself, but instead may represent correlates of density of the particular suite of predators found at the site. However, even if that were the case, our findings remain relevant for at least this site.

We identified a variety of variables that were significantly associated with nest success in both bivariate and multiple regression analyses, although the two analyses found different sets of correlates (Tables 7 & 8). Generally, nest success tended to be higher in more mature patches: those with taller and more closed canopies, more trees in the larger size classes (and so higher basal area), and fewer trees in the smallest size class. Bivariate regressions suggested that nest success tended to increase with distance from the nearest occupied patch, though any biological explanation for such a relationship is unclear. As nearest occupied patch was not found to be a significant predictor of patch-wise nest success in the logistic regression analysis, its inclusion in the bivariate may be an artifact of this particular data set or completely spurious. Equally inexplicable was the inclusion in the logistic regression of both patch area and floodplain width, both negatively correlated with nest success. Perhaps larger patches, or patches in wider floodplains, were more likely to be used as hunting grounds for the major avian predators at the site (Cooper's Hawk *Accipiter cooperii*, and Common Raven *Corvus corax*). Further work is needed to verify and understand these relationships.

As with nest success, the patch-wise rates of brood parasitism were associated with different variables in the bivariate and multiple regression analyses. The bivariate analyses suggested that as patch width, and so area, increased, so did average parasitism rates. Why this might be so is unclear, as it seems contrary to patterns reported from fragmented forests in the Midwest and Eastern states (Robinson et al. 1995). One possible explanation is that like other flycatchers, Willow Flycatchers demonstrate conspecific attraction – that is, birds tend to be clumped in distribution across a landscape. Anecdotal information suggests that dispersing birds, especially young birds, are most likely to settle close to other flycatchers whenever possible, rather than cuing in to any particular aspect of the habitat itself (Muller et al. 1997). By doing so, larger clusters of flycatchers in larger patches are more likely to include many young, inexperienced birds occupying less suitable or marginal microhabitats within the patch. These inexperienced birds are most likely to be the ones parasitized or depredated. Such a pattern was documented in Hooded Warblers (*Wilsonia citrina*; Stutchbury 1997).

Based on the logistic regression analysis, box elder was the only significant predictor of patch-wise parasitism rates. With an increasing proportion of box elder, patch parasitism rates tend to decline. This result may help to explain why these flycatchers prefer box elder as a nesting tree. In previous analyses at the scale of nest site, we found that nests in box elder were much less likely to be parasitized than were nests in either willows or Russian olive, the next most frequent nesting substrates in this population (Stoleson and Finch in review).

Landscape-level processes in a linear riparian ecosystem. – Edge effects are best recognized at the scale of individual nests, rather than whole patch. However, as narrower patches have a greater portion of their area close to edges than do wider patches, any correlate of patch width could be considered an indication of an edge effect. Patch width was significantly correlated only with brood parasitism, and that was a positive correlation: the wider the patch, the higher the average parasitism rate. This contrasts with the predicted pattern if edge effects pertained to this system. In previous analyses at the nest site scale, we found no significant differences in distance to edge between successful and failed nests, or between parasitized and nonparasitized nests, supporting our finding reported here of no evidence for edge effects (Stoleson and Finch 1999a).

Evidence for patch size effects. – Although larger patches were more likely to be occupied by flycatchers, we found no data to indicate that patch size affected Willow Flycatchers in the same way it affects forest interior species in the East. Our analyses suggest that average rates of nest success actually decreased with increasing patch size, and brood parasitism rates increased with increasing patch size – both opposite to the usual conception of patch size effect. Willow Flycatchers in the Southwest occur in habitat that is naturally patchy, so it was expected that we found no negative impact of small patch size. However, the opposite effect, of apparent benefit from smaller patches, is unexpected. As mentioned above, this apparent inverse effect may result from conspecific attraction. It should be noted that in eastern forests, benefits from breeding in larger patches accrue only with patches >1000 m wide – much larger than any habitat patches found on the Gila River (Robinson et al. 1995).

Management implications. – Although grazing has been identified as a major causal factor for the decline and endangerment of the southwestern Willow Flycatcher (USFWS 1995), we found no significant negative impact of grazing on flycatcher nest success or brood parasitism in this system. In fact, grazing was associated with a higher likelihood of patch occupancy and higher densities of flycatchers. This association does not necessarily reflect a causal relationship, however.

We feel the reason for this apparent paradox is the type of grazing management practiced at our study site, compared to that practiced in other areas of the Southwest. Almost all of our grazed patches are part of the U Bar Ranch, which practices a very progressive management style based on rapid rotations and adaptive management. They employ no fixed rotation schedules, and most patches that are grazed support cattle only in fall and/or winter, and then for brief periods. How our assessment of grazing impacts might apply to other grazing management practices is unknown. The type of management practiced by the U Bar is becoming increasingly common throughout the West, however (Ehrhart and Hansen 1997, Leonard et al. 1997).

Importance of box elder. – It should be apparent that the one factor most significantly and strongly associated with Willow Flycatcher occurrence and success in the Cliff-Gila Valley is the prevalence of box elder. This tree species seems to define prime flycatcher habitat both at the nest site and patch levels. Our study site is unusual among Southwestern Willow Flycatcher sites in the use of box elder, primarily because most of this tree's range lies well above the elevations where the flycatcher is most frequently found. Furthermore, box elder is most common along steep-sided, high-gradient montane streams (Carter 1997), which are unsuitable for Willow Flycatchers. Thus, our findings concerning box elder may be mostly irrelevant to most other active Willow Flycatcher sites in the Southwest. However, these results may be very important within this valley, and in other floodplain riparian areas at similar or higher elevations. In these mid-elevation areas, flycatchers may benefit from management that actively promotes box elder. Box elder is a secondary successional, shade-tolerant species that may become established only slowly, if ever, in disturbance-prone sites.

Future Project Goals

In 2001, we hope to expand our characterization of Willow Flycatcher habitat at larger spatial scales to allow a more robust analysis. Specifically, we hope to measure more habitat patches in the Cliff-Gila Valley, including more patches of younger growth. Most of the analyses presented here pertain to patches rather than landscapes. Therefore, we will work to obtain more and better measures of landscape-level features, such as stream gradients, canyon depths, and channel widths. We will also continue to band birds and begin to analyze patterns of within-site movement, site fidelity, and survival. And, as in previous years, we will conduct official flycatcher surveys in collaboration with Paul Boucher of the Gila National Forest, and find and monitor flycatcher nests.

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APPENDIX. Population estimates of Willow Flycatchers by patch in the Cliff-Gila Valley, New Mexico, based on protocol surveys. Numbers are: pairs (+ probable single territorial males).

PATCH	Survey 1 (5/25 - 5/26)	Survey 2 (6/14 - 6/19)	Survey 3 (7/5 – 7/7)
NW1	1 (+5)	4 (+1)	4
NW2	0	0	0
NW3	0	1	3
NW4	12 (+5)	15 (+4)	16 (+1)
Bennett project	0	0	0
NW5	0 (+1)	0 (+1)	1
NW Stringer	0 (+4)	3 (+3)	3 (+2)
NE1	0	0 (+1)	0
NE2	0	0	1
NE3	1 (+ 2)	4 (+2)	1
NE4	3 (+5)	8 (+2)	5 (+1)
NE5	3 (+4)	3	3 (+1)
SW1	1 (+1)	2 (+1)	3
SW2	2 (+1)	5	5 (+1)
SW3	1 (+2)	3	5
SW4	0 (+1)	1 (+2)	2
SW5	0	0	0
SW Crescent	0	1 (+1)	0
SW Stringer	2 (+1)	1 (+2)	3 (+2)
SE1	7 (+11)	19 (+2)	35
SE2	3 (+1)	14	8 (+1)
SE3	5 (+1)	7 (+1)	6
SE4	6 (+1)	6 (+1)	5
SUBTOTAL U Bar	47 (+46) = 93 terr.	97 (+24) = 121 terr.	109 (+9) = 118 terr.
Fort West Ditch	0 (+5)	4 (+1)	4
Gila Bird Area	0	4 (+1)	2
TOTAL	47 (+51) = 98 terr.	105 (+26) = 131 terr.	115 (+9) = 124 terr.

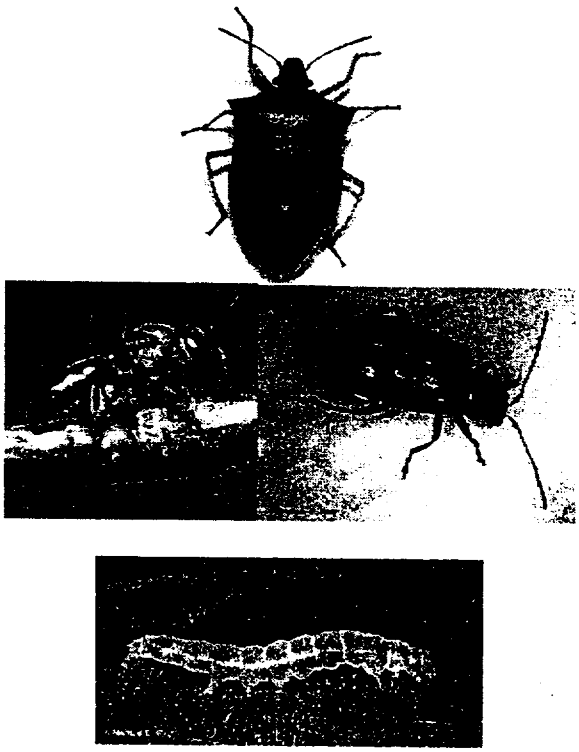
ATTACHMENT "C"

ATTACHMENT "C"

SOUTHWESTERN WILLOW FLYCATCHERS IN THE CLIFF-GILA VALLEY, NEW MEXICO

SURVEY RESULTS, NEST MONITORING, AND A PRELIMINARY ANALYSIS OF WILLOW FLYCATCHER DIET

Draft Summary Report for the 2001 Field Season
March 2002



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EXECUTIVE SUMMARY

The year 2001 was similar to 2000 for Southwestern Willow Flycatchers in the Cliff-Gila Valley. Population size increased only slightly, although the birds' distribution within the Valley changed somewhat. Notably, the number of breeding pairs in the Bennett Restoration project increased to 6 pairs, making that project's flycatcher population larger than that of 75% of the approximately 200 known sites rangewide.

We located 132 Willow Flycatcher nests. As in 2000, the average nest success was high – 67% overall. Nest success was particularly high in box elder (*Acer negundo*), and poor in willows (*Salix* spp.). Many birds had second broods. Unlike 2000, cowbirds were rather common this past year, and the flycatchers were subject to relatively high levels (16.5%) of parasitism. We noted the first reported instance of nest predation by American Kestrels *(Falco sparverius)*. As per usual for this site, most nests (81%) were in box elder, and most were place high (average = 8.5 m). In 2001, we found the first two documented Willow Flycatcher nests in net-leafed hackberry (*Celtis reticulata*).

We report here the results of a collaborative study of flycatcher diet initiated in 1999. Based on fecal samples from 23 banded birds and insect sampling conducted in 1999, we demonstrate that Gila birds ate a variety of prey taxa, predominately bees and wasps, but also substantial amounts of true bugs, true flies, and beetles. Proportions of arthropod taxa in the Gila diet differed from those at sites in Arizona and California. We used sticky traps to sample the arthropod community in three riparian patches on the Gila that varied in density of flycatchers and amount of water. Little difference was found among the three sites; what variation there was in arthropod abundance did not correspond to flycatcher densities. Because the flycatcher diet on the Gila was more similar to diets elsewhere in the Southwest than it was to the general arthropod community on the Gila, we suggest that the Southwestern Willow Flycatcher may be a diet specialist rather than a generalist. As such, there is the potential for the subspecies to be subject to food limitation.

INTRODUCTION

The Southwestern race of the Willow Flycatcher (*Empidonax traillii extimus*) is a critically endangered Neotropical migrant bird that breeds exclusively in densely vegetated riparian areas in the region. Approximately 900 pairs were known to exist in 2000, with the largest population in the upper Gila River Valley in New Mexico (USFWS 2001). It is currently considered the top priority species for US Fish and Wildlife Service Region 2.

Although recent research has shed light on various aspects of Willow Flycatcher biology and habitat associations (see Finch and Stoleson 2000, U.S. Fish and Wildlife Service 2001), its food habits remain only poorly known. Previous information on diet has been only cursory (Beal 1912, Bent 1942, and McCabe 1991). To date, two descriptive diet studies have been conducted on the southwestern subspecies at several sites in California, Arizona and Colorado (Drost et al. 1998, 2001). Based strictly on analysis of fecal samples, those studies documented a wide variety of arthropod prey including both aquatic and terrestrial taxa. This variety of prey items suggests the Willow Flycatcher may be considered a generalist insectivore, but that characterization cannot be made without an understanding of prey availability. Whether or not the Willow Flycatcher is indeed a generalist or whether it specializes in particular prey has important implications for management, especially since observed diets varied among habitat types (Drost et al. 1998) and among sites (Drost 2001).

OBJECTIVES

Our goals for this study in 2001 were:

1. Survey for flycatchers following standardized protocols to estimate population sizes in the Cliff-Gila Valley.
2. Locate and monitor nests of Willow Flycatchers to assess levels of nesting success, cowbird parasitism and predation.
3. Characterize and quantify vegetation at nests sites.
4. With collaborators from the New Mexico Natural Heritage Program and Colorado State University, describe quantitatively the diet of the Willow Flycatcher.

Due to insufficient funding, no banding was conducted in 2001.

This report presents the results of the fifth year of the study.

METHODS

Study area. – The Cliff-Gila Valley of Grant County, NM, comprises a broad floodplain of the Gila River, beginning near its confluence with Mogollon Creek and extending south-southwest toward the Burro Mountains. The study was primarily conducted from just below the US Route 180 bridge upstream to the north end of the U-Bar Ranch (approximately 5 km). In addition, flycatchers were studied in two disjunct sections of the valley: (1) the Fort West Ditch site of the Gila National Forest and adjacent holdings of The Nature Conservancy's Gila Riparian Preserve, located about 9 km upstream of the Route 180 bridge, and (2) the Gila Bird Area, a riparian restoration project comprising lands of the Gila National Forest and Pacific-Western Land Company, located some 8 km downstream of the Route 180 bridge. Most of the Cliff-Gila Valley consists of irrigated and non-irrigated pastures used for livestock production and hay farming. Elevations range from 1350 to 1420 m.

The Gila River and nearby earthen irrigation ditches are lined with riparian woodland patches of various ages and composition. Most patches support a mature woodland (>25 m canopy) of Fremont cottonwood (*Populus fremontii*), with a subcanopy of mixed deciduous trees including box elder (*Acer negundo*), Goodding's willow (*Salix gooddingii*), velvet ash (*Fraxinus velutinus*), Arizona walnut (*Juglans major*), Arizona sycamore (*Platanus wrightii*), Arizona alder (*Alnus oblongifolia*) and Russian olive (*Elaeagnus angustifolia*). The understory is composed of shrubs including three-leaf sumac (*Rhus trilobata*), false indigo (*Amorpha fruticosa*), New Mexico olive (*Forestieria neomexicana*), forbs, and grasses. Fewer patches support a shrubby, early successional growth of seepwillow (*Baccharis glutinosa*), coyote and bluestem willows (*Salix exigua* and *S. irrorata*), and saplings of the species mentioned above. Most habitat patches are less than 5 ha in area. The FS Fort West Ditch site and the Gila Bird Area are generally more open than patches on the U-Bar. In addition to the primary patches of riparian woodland along the Gila itself, numerous stringers of riparian vegetation extend along many of the earthen irrigation ditches. These stringers contain the same plant species as larger forest patches, but rarely exceed 10 m in width.

Surveys. – All riparian habitats within each site were surveyed systematically for Willow Flycatchers using standardized techniques developed by the USFWS (Sogge et al. 1997). Three surveys were conducted at each site during the periods of 15-30 May, 1-21 June, 22 June-15 July. Survey procedures entailed two observers walking through or adjacent to riparian habitat on clear, calm days between dawn and noon. Recordings of Willow Flycatcher vocalizations were played periodically to elicit responses from territorial birds. We recorded data on numbers of flycatchers, evidence of breeding by flycatchers, and presence of Brown-headed Cowbirds. All personnel of the Rocky Mountain Research Station held valid state and federal permits required for surveying and monitoring Southwestern Willow Flycatchers, and attended a mandatory survey protocol training session before initiating fieldwork.

Nest monitoring. – We searched for nests of Willow Flycatchers and other species on a daily basis. Nests were monitored every 3-7 days, following a modified (less-intrusive) version of protocols proposed by the Arizona Game and Fish Department (Rourke et al. 1999). Nest contents were observed using pole-mounted mirrors or videocameras, or 15X spotting scopes. Nests that were abandoned or destroyed were examined for evidence (e.g., cowbird eggs, mammal hairs) to ascertain causes of nest failure. We considered a nest successful if: (1) parent birds were observed feeding one or more fledged young; (2) parent birds behaved as if dependent young were nearby when the nest was empty (defensive or agitated behavior near nest); or (3) nestlings were in the nest within one or two days of the estimated fledge date. We considered a nest failed if: (1) nest contents disappeared before fledging of young was possible, assuming 10-12 d required for fledging (depredation), (2) the nest contained no Willow Flycatcher young but contained cowbird eggs or chicks (parasitized), (3) the nest was deserted after eggs had been laid (desertion), or (4) the nest was abandoned prior to egg laying (abandonment).

Collection of diet samples. – In 1999,we collected fecal samples from adult Willow Flycatchers captured in mist-nets by their voluntary evacuation during net retrieval, processing (banding, measuring, etc.), and holding. After processing each bird, we held it in an opaque, well-ventilated cotton bag in an undisturbed location for at least 20 minutes before release. We collected additional fecal deposits opportunistically. Droppings were immediately placed in glass vials containing 70% Ethanol. Location, date, and sample number were written on each vial. Additional information on bird and habitat could be referenced from the sample number. A total of 23 fecal samples were collected during late May, late June and late July 1999.

Identification of diet samples. – Individual samples were transferred to microscope dishes and examined under a 10-45x stereo-zoom microscope. Fragments of bodies, wings, legs, head capsules, mouthparts, or antennae were sorted, grouped, and identified to the finest taxon based on comparisons to reference arthropods and taxonomic literature. Our reference of distinguishable arthropod parts came from sweep-net samples of the foliage during the same dates. For each taxon, we estimated the minimum number of individuals represented based on recognizable parts (e.g. pairs of wings, or head capsules).

Statistical description of diet samples. – We summarized diet samples in several ways: number of prey items per sample, number of different identified taxa per sample, number of each prey taxon across all samples, and percent occurrence (frequency) of each prey taxon in samples (proportion of samples in which a specific prey taxon was found). Small sample sizes precluded any statistical analysis of temporal trends within groups. For analyses we used and present information on the 6 most frequent arthropod orders, and pool all others as *other*.

Collection of arthropod community samples. – To sample the arthropod prey available within Willow Flycatcher habitat, we used sticky traps (Cooper and Whitmore 1990) placed in 3 different riparian patches in the Gila Valley. One patch (SE1) was adjacent to the Gila River, received irrigation runoff, contained a swampy wetland, and supported a very high density of flycatchers (7.7 pairs/ha). Another patch (NW1) was adjacent to the river and supported a low density of flycatchers (1.5 pairs/ha). The third patch (NW2) was distant (>200 m) from the river and other water sources and had no flycatchers. Otherwise, the woodlots were similar in size (4.2 – 5.1 ha) and vegetation composition and structure.

We randomly selected trees used for nesting by flycatchers in 1998 as arthropod sampling sites in SE1 (10 sites) and NW1 (8 sites). As the NW2 patch did not support breeding flycatchers, we selected 8 pseudo-nest trees based on a qualitative assessment of the available vegetation that was most similar to nest sites in occupied patches. All pseudo-nest trees selected in NW2 were box elders comparable in height (8-16 m) and structural complexity to those used in the other two patches.

For six weeks beginning 6/10/99, we placed 3 fresh sticky traps around nest trees each week based on the following protocol. A random azimuth and distance (between 0-15 m) from the nest tree were chosen to locate the first sticky trap. Second and third traps were placed at random distances (0-15 m) from the nest tree, at 120° and 240° from the first trap for maximum radial spacing between traps. Sticky traps were hung 1-2 m off the ground in the vegetation at each selected point using tiepins. For points lacking vegetation, we fastened traps approximately 1 m off the ground to wooden survey stakes inserted in the ground. Each trap was exposed for a period of 4 days, as test samples indicated at least some sticky traps approached saturation with arthropods after 4 days exposure.

ANALYSES

Overlap index. – We used two indices to quantify dietary overlap: Horn's index and Pianka's index (Litvaitis et al. 1996). Drost's studies (1998, 2001) report only summary data, so we were unable to use the somewhat more precise Morisita's Index (Litvaitis et al. 1996). The formula for Horn's index is

$$R_o = \frac{\sum (P_{ij} + P_{ik}) \log (P_{ij} + P_{ik}) - \sum P_{ij} \log P_{ij} - \sum P_{ik} \log P_{ik}}{2 \log 2}$$

and that of Pianka's index is

$$O_{jk} = \frac{\sum P_{ij} P_{ik}}{\sqrt{\sum P^2{}_{ij} \sum P^2{}_{ik}}}$$

where P_{ij} = proportion order i is of total prey taken at location j, and P_{ik} = proportion order i is of total prey taken at location k. The formulae yield R_o and O_{jk}, estimates of the percent of diet overlap, at the taxonomic level of order, between flycatchers at locations j and k. We compared the proportions of arthropod orders detected in fecal samples to their proportions in sticky trap samples to assess whether prey items were taken in proportion to their abundance. We compared Southwestern Willow Flycatcher diet in the Gila Valley to that reported from three other sites: the Kern River Preserve (n = 16 samples), the Salt River inflow to Roosevelt Lake (n = 11), and the Tonto Creek inflow to Roosevelt Lake (n = 9). All comparisons are based on fecal samples obtained from breeding adult flycatchers at each site. Data from the Kern Preserve and Roosevelt Lake sites come from Drost et al. 1998 and Drost et al. 2001.

RESULTS

Climate in 2001. – The drought that impacted the Cliff-Gila Valley in 1999 and 2000 continued intermittently into July of 2001. Substantial rains fell in the Cliff area in October and November of 2000, but failed to make up for the net deficit in precipitation. That net deficit continued throughout 2001 (Table 1). The monsoon rains began relatively early in June of 2001 but were light until August, when most flycatcher breeding was already complete. Thus, the overall pattern of precipitation pattern for the 2001 breeding season was generally dry.

Table 1. Precipitation at Cliff, New Mexico, for 2000 and 2001, and annual averages for 1936-1999. Data from the Western Regional Climate Center (2001).

	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sep.	Oct.	Nov.	Dec.	TOTAL
2000 precip.	0.06	0.07	0.80	0.03	0.00	2.19	1.63	2.54	0.04	3.20	2.14	0.18	12.88
2001 precip.	0.74	0.84	0.08	0.68	0.34	0.74	1.70	5.13	0.84	0.00	0.28	0.00	11.37
Average (1936-99).	1.00	0.94	0.86	0.33	0.35	0.53	2.77	2.84	1.65	1.28	0.71	1.16	14.52
2001: % of normal	74	89	9	206	97	140	61	181	51	0	39	0	78
2001: cumulative (in.) deviation from norm since Jan '01	-0.3	-0.4	-1.1	-0.8	-0.8	-0.6	-1.7	0.6	-0.2	-1.5	-1.9	-3.1	
2001: cumulative (in.) deviation from norm since Jan '00	-1.8	-1.9	-2.7	-2.3	-2.3	-2.1	-3.2	-0.9	-1.7	-3.0	-3.4	-4.6	

Willow Flycatcher population surveys. – In 2001, the number of Willow Flycatchers in the Cliff-Gila Valley remained about the same as in 2000 (Fig. 1). A total of 132 territories were detected, of which 126 were found on the U Bar Ranch. The number of birds on the U Bar actually increased slightly (4%) compared to last year, while the number elsewhere in the valley dropped by another 40% (Appendix). The birds remained relatively common in the core areas of prime habitat, but showed some subtle changes in distribution within the Valley. The number of birds in the large SE1 patch declined considerably, from over 50 pairs in 1998-99 to only 20 pairs in 2001. Part of this apparent change may have been a lower detection rate due to both fewer observers in the field, and attenuation on the part of the flycatchers to the tape used for surveying. On several surveys we failed to detect all the pairs whose nests we were then monitoring, which indicates that the survey protocol regularly underestimates the number of birds. Perhaps the most notable change was in the Bennett Restoration project, which this year supported at least six breeding pairs. Also, a single pair recolonized NW2, which has not had flycatchers since at least 1995.

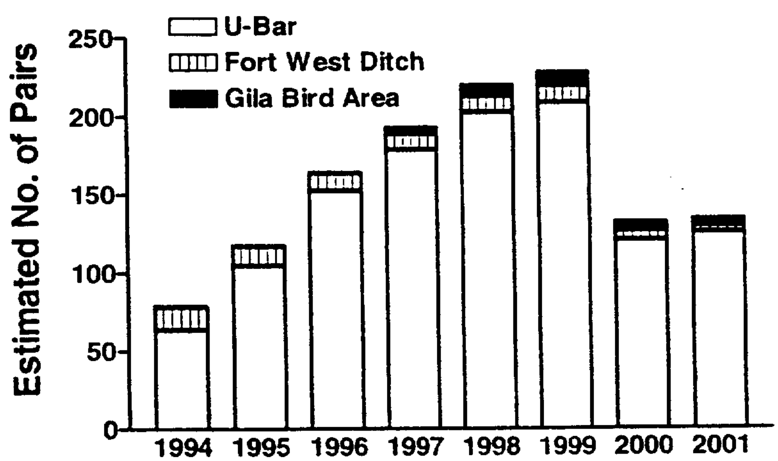

Figure 1. Population estimates of Willow Flycatchers in the Cliff-Gila Valley, 1994-2001.

Flycatcher nests. – Willow Flycatchers in the Cliff-Gila Valley bred prolifically in 2001. W located 132 nests, and found evidence (fledglings) of another 4 that were never located. Of these, 107 (81%) were placed in box elder, a proportion similar to the 84% in 2000. Willows were the next most frequent nest tree (11 = 8%). A few nests were found in several other tree species (Table 2). Of note were two nests (consecutive attempts by a single pair) in a single large net-leaf hackberry (*Celtis reticulatus*). We believe this report constitutes the first known use of this species by Southwestern Willow Flycatchers (Sedgwick 2000, USFWS 2001). Willow Flycatchers appeared to nest especially high in 2001. Nest heights ranged from 2.0 to 22.9 m in height, with a mean height of 8.5 ± 4.0 m and a median of 8.4 m (Table 3). As usual, the highest nests were in box elder.

Table 2. Nest substrates, nest heights, and comparative nest success by substrate (based on nests of known outcome) for Willow Flycatcher nests in the Cliff-Gila Valley, 2001.

Nest Substrate	N	Mean nest ht. (m)	Range nest ht. (m)	% successful (N)
Box elder	107	9.5 ± 3.5	2.0 – 22.9	74% (81)
Goodding's willow	10	3.2 ± 1.4	2.0 – 6.0	0% (7)
Fremont cottonwood	6	5.3 ± 2.5	3.0 – 10.0	33% (3)
Seepwillow	2	3.1	2.2 – 4.0	50% (2)
Net-leaf hackberry	2	4.2	3.9 – 4.5	50% (2)
Saltcedar	2	3.1	2.9 – 3.3	50% (2)
Russian olive	1	8.0	–	100% (1)
Arizona alder	1	12.0	–	100% (1)
Coyote willow	1	2.0	–	– (0)
TOTAL	132	8.5 ± 4.0	2.0 – 22.9	67% (99)

Willow Flycatcher nest success. – As in 2000, flycatchers in the Cliff-Gila Valley enjoyed very high rates of nesting success in 2001, despite (or perhaps because of) relatively low population numbers. Again this past year, 67% of nests fledged one or more young. As in 2000, many pairs raised a second brood after successfully fledging their first: an estimated 19 were second broods after successful first broods. In addition to the 132 nests that were found, we found fledglings being fed in four territories where no nest was found. A minimum of 80 fledglings was produced from flycatcher nests on the U Bar, although the actual number was probably two or more times that amount. As in previous years, the likelihood of a nest being successful appeared to vary among nest tree species, although small sample sizes for most species preclude statistical analysis. Almost three quarters of nests in box elder fledged young, compared to no success in Goodding's willow (Table 2).

Causes of nest failure. – Of the 34 nests known to have failed, ten failed due to unknown causes (although these were probably depredated). Six failed due to weather (blown out of tree during a storm). The remainder failed due to predators (n = 8), abandonment (n = 6), or cowbird parasitism (n = 4). This year we witnessed one nest with older fledglings (ca. d. 9-10) being depredated by an American Kestrel (*Falco sparverius*), the first recorded instance of this small raptor as a predator on flycatchers.

Cowbird parasitism. – Brown-headed Cowbirds (*Molothrus ater*) appeared to be particularly abundant in the Cliff-Gila Valley in 2001 compared to prior years. We witnessed at least 5 Lucy's Warblers (*Vermivora luciae*) feeding cowbird fledglings; this cavity-nesting species tends to be parasitized only very rarely (Stoleson et al. 2000). Among other species we monitored opportunistically, 35% of Blue Grosbeak (*Guiraca caerulea*) nests and 45% of Yellow-breasted Chat (*Icteria virens*) nests were parasitized. Among the 85 Willow Flycatcher nests for which we could positively ascertain parasitism status, 14 (16.5%) were parasitized; 4 of these still fledged flycatcher young successfully. Most of the nests of unknown parasitism status were high nests that were successful, and so probably were not parasitized.

Willow Flycatcher diet on the Gila. – Flying Hymenoptera (bees and wasps) constituted 42% of the identifiable insect remains in the fecal samples from the Gila Valley (Table 3). Another 42% consisted of Hemiptera (true bugs), Coleoptera (beetles), and Diptera (true flies). The remainder of the fecal samples included ants (Hymenoptera), Homoptera (plant/leafhoppers), Thysanoptera (thrips), Odonata (damselflies, dragonflies), Neuroptera (lacewings, snakeflies), and miscellaneous material such as sand grains and willow flower parts (Table 1). Fifty-three percent of the Hymenoptera in our samples were a small bee (subfamily Apoidea, 1-2 mm in size). The remainder consisted of parasitic wasps such as cuckoo wasps (family Chrysididae), chalcid wasps (superfamily Chalcidoidea) and a medium sized sphecoid wasp, superfamily Sphecoidea.

The Hemiptera parts in the samples resembled those of seed bugs (family Lygaeidae) and leaf bugs (family Miridae). Coleoptera fragments found were less than 3 mm. Diptera identified were primarily of the suborder Nematocera that includes midges and gnats. A dance fly (family Empididae) was identified. Only two aquatic invertebrates were found, a damselfly and a lacewing (Table 1). The frequency of diet items (proportion of samples in which a taxon was identified) followed a pattern similar to the abundance of taxa among all samples. Hymenoptera was the most widespread order, being found in over half of all samples. The other most frequent taxa were true bugs (Hemiptera), beetles (Coleoptera), and true flies (Diptera) (Table 3).

Arthropod Community Structure on the Gila. -- Sticky trap samples at all three Gila sites were overwhelmingly dominated by thrips (Thysanoptera). Other predominant orders were Diptera, Hymenoptera, Coleoptera, Homoptera, and Araneae (Table 4).

The proportion of arthropod orders among Cliff-Gila sample sites was very similar: each pair of sites had >88% overlap (Table 4). The proportion of arthropod orders at the site with the high WIFL density (SE1) was most similar to that at the dry no-WIFL site (NW2), with an overlap index of 90%. The SE1 site showed slightly lower overlap with the intermediate site (NW1), but overall there was no statistically significant difference among sites in the proportion of arthropods among orders ($\chi^2 = 9.7$, df = 12, $P = 0.64$).

Table 3. Numbers and percent frequency of prey taxa in the diet of mist-netted Southwestern Willow Flycatchers from the Gila National Forest, New Mexico based on fecal samples collected during May to July, 1999 (n = 23 samples). Taxa are listed in descending order based on numbers of individuals identified in the samples. Category Other was excluded from percentage of prey. Frequency in samples (%) is the number and percentage of samples in which that taxon was identified.

Order	Common prey/ items	Number of prey (%)	Frequency in samples (%)
Hymenoptera	bees, wasps	25 (42)	12 (52)
Other	sand grains, willow flowers and pollen	16	3 (13)
Hemiptera	true bugs	10 (17)	8 (35)
Coleoptera	beetles	9 (15)	7 (30)
Diptera	true flies	6 (10)	5 (22)
Hymenoptera/ant	ant (wingless)	3 (5)	3 (13)
Homoptera/cicadellid	plant/leafhoppers	3 (5)	2 (9)
Thysanoptera	thrips	1 (2)	1 (4)
Odonata	damselflies, dragonflies	1 (2)	1 (4)
Neuroptera	lacewings, snakeflies	1 (2)	1 (4)
None	digested material	1	

Table 4. Numbers (and percentages) of arthropods collected in sticky traps at three sites in the Cliff-Gila Valley, N.M. The three sites supported high density (SE1), low density (NW1), and no Southwestern Willow Flycatchers. Taxa are listed in the same order as in Table 3.

		Site		
Order	Prey Type	SE1	NW1	NW2
Hymenoptera	bees, wasps, ants	1,084 (4.8)	1,485 (9.1)	1,516 (8.1)
Hemiptera	true bugs	228 (1.0)	138 (0.8)	69 (0.4)
Coleoptera	beetles	830 (3.6)	1,332 (8.2)	1,026 (5.5)
Diptera	true flies	3,208 (14.1)	3,369 (20.7)	2,927 (15.7)
Homoptera/cicadellid	plant/leafhoppers	1,013 (4.4)	941 (5.8)	619 (3.3)
Thysanoptera	thrips	15,990 70.3	8,423 (51.8)	12,011 (64.4)
Odonata	damselflies, dragonflies	0 (0)	0 (0)	0 (0)
Neuroptera	lacewings, snakeflies	0 (0)	7 (<0.1)	2 (<0.1)
Aranaea	spiders	223 (1.0)	308 (1.9)	226 (1.2)
Other	all other	182 (0.8)	276 (1.7)	261 1.4

The numbers of arthropods sampled by sticky traps did vary significantly among the three Gila sites and over time (ANOVA with site and week as classifying factors: $F_{16, 21761}$, $P < 0.01$). Post hoc tests (Bonferroni) indicated arthropod numbers were significantly greater in SE1 than in NW2, and significantly greater in NW2 than in NW1 (see Table 4). These results were similar whether thrips were included in analyses or not. Numbers of Hymenoptera, the most common prey taxon, were inversely correlated with flycatcher density: SE1 had the fewest and NW2 had the highest numbers. Because there were no significant differences in the proportions of prey taxa among the Cliff-Gila sample sites, we compared our diet samples to a composite arthropod community from all 3 sites.

Comparison of flycatcher diet with the Gila arthropod community. -- The proportions of arthropod orders represented in the diet samples differed significantly from the proportions determined from our sticky traps ($\chi^2 = 113.2$, df = 7, $P < 0.001$). The degree of overlap between diet and sticky traps was only 45% based on Horn's index, and only 21% based on Pianka's index.

Thrips made up an overwhelming proportion of the arthropods in our sticky traps, yet appeared to be taken only rarely by the flycatchers (Tables 3 & 4). It may be inappropriate to consider thrips as available prey since the birds rarely took them, and to do so is likely to skew comparisons of diet and available arthropods. We therefore compared the proportion of arthropod orders in flycatcher diets and sticky traps excluding thrips from both samples. Again, the diet differed significantly from the traps ($\chi^2 = 51.0$, df = 6, $P < 0.001$). The degree of overlap was 67% by Horn's index, and 60% by Pianka's. Both Hymenoptera and Hemiptera were over-represented in the diet samples compared to the sticky traps (Figure 2). Homoptera and Diptera were disproportionately scarce in the diet samples. Coleopterans were taken in proportion to their abundance.

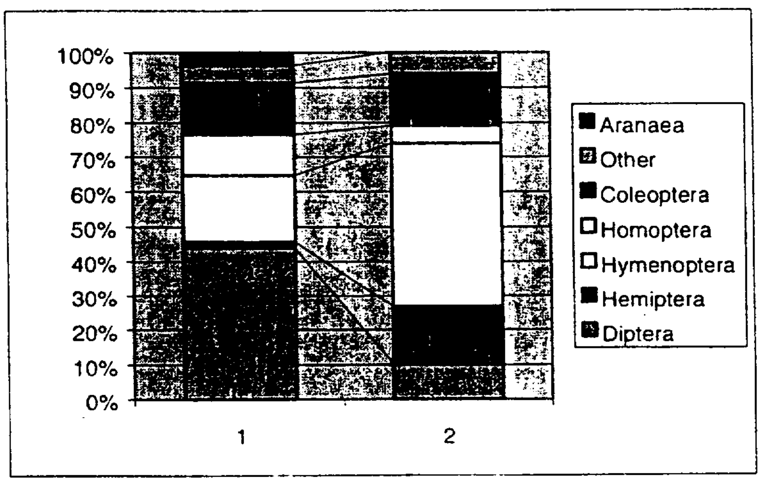

Figure 2. Proportions of major arthropod orders in Southwestern Willow Flycatcher diet (2) and the arthropod community as sampled by sticky traps (1). These graphs exclude thrips (Thysanoptera); differences are exaggerated when thrips are included.

Willow Flycatcher diet among breeding sites. -- The composition of Willow Flycatcher diets was only moderately similar among breeding sites: levels of overlap ranged from 71% to 83% based on Horn's index, and 52% to 84% based on Pianka's index (Table 5, Figure 3). The Gila differed significantly from the other three sites (all $\chi^2 \leq 29.0$, df = 6, $P < 0.001$). Diet on the Gila was most similar to that on the Tonto, and most different from the Kern Preserve (Figure 3). The two sites on Roosevelt Lake (Tonto and Salt) were the most similar to each other (Table 5).

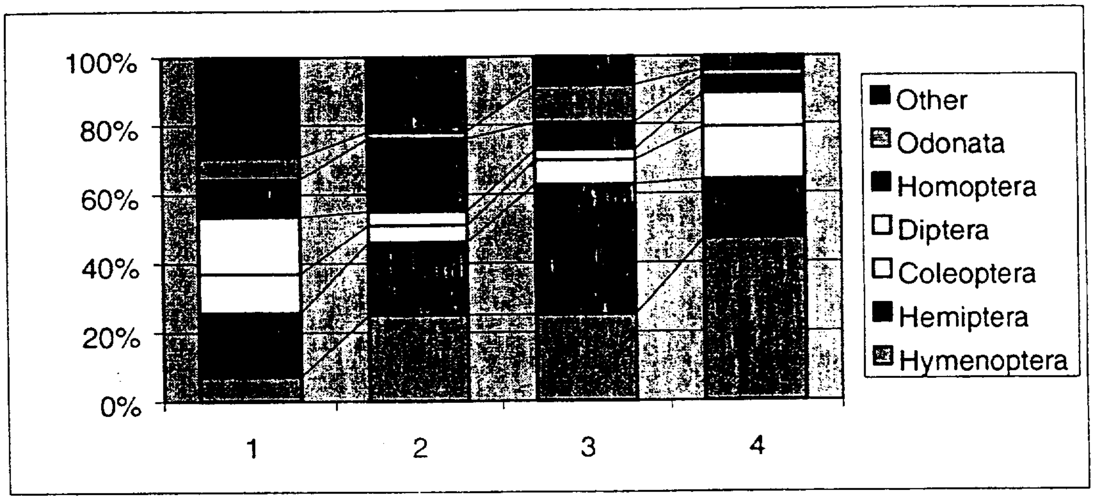

Figure 3. Proportions of major arthropod orders in the diet of Southwestern Willow Flycatchers at (1) the Kern River, CA, (2) Salt River, AZ, (3) Tonto Creek inflow to Roosevelt Lake, AZ, and (4) Cliff-Gila Valley, NM.

Compared to other sites, Gila birds preyed to a much greater extent on bees and wasps. Remains of these Hymenoptera groups were found in 52% of Gila samples, versus 36% of Kern samples. Data on frequency of prey items in samples are not available for the Arizona sites, but flying Hymenoptera were the most abundant taxa among all prey items recorded from the Salt, and the second most abundant on the Tonto (Drost et al. 2001). Beetles (Coleoptera) also made up a proportionally larger share of the diet on the Gila than elsewhere. In contrast, the proportion of leafhoppers and other Homopterans in the flycatcher diet was lowest among the Gila birds. Still, the distribution of arthropod orders in the diet of Willow Flycatchers on the Gila was more similar to that in diets in Arizona than it was to the general arthropod community from which it was taken on the Gila.

Table 5. Estimates of diet overlap among four Willow Flycatcher sites based on Horn's index (upper right), and Pianka's index (lower left).

	KERN	SALT	TONTO	GILA
KERN	-	0.82	0.77	0.71
SALT	0.82	-	0.83	0.78
TONTO	0.62	0.84	-	0.81
GILA	0.52	0.76	0.79	-

The Kern samples contained a variety of arthropod taxa not found in the Gila samples, despite our larger sample sizes. We found no recognizable termites (Isoptera), spiders (Araneae), moths and butterflies (Lepidoptera), isopods (Isopoda), or mites (Acari) in the Gila diet samples, although Lepidoptera, mites, and spiders were found in sticky trap samples.

DISCUSSION

Flycatcher numbers. – Despite a very high rate of nest success in 2000, the Cliff-Gila population of Willow Flycatchers did not grow appreciably in 2001. Possible reasons for this include: (1) low post-fledging survival either on migration or on the wintering grounds; and (2) high rates of dispersal of young birds to other sites. We have no data to explore these possibilities. However, post-natal dispersal is the norm in songbirds, and improvements in riparian habitats in numerous nearby drainages suggest that the amount of suitable habitat into which young birds could disperse is increasing rapidly. Apparently the small population downstream near Redrock, NM, has grown considerably in recent years. This growth may be due to emigration from the Cliff-Gila Valley, which is likely to function as a source population. The increase in the number of flycatchers nesting in the Bennett Restoration Project is notable, especially in light of the resistance from the USFWS and some locals to plans to carry out similar projects on the U Bar. Six breeding pairs in the Bennett give that project area alone a larger flycatcher population than over 75% of known Willow Flycatcher *sites* (USFWS 2001).

As in 2000, the flycatchers enjoyed high rates of nest success, and many pairs double-brooded. High success was achieved despite the relatively high abundance of cowbirds and high rates of parasitism in other species. These patterns reflect those recorded in 2000. We hypothesized that the lower populations of flycatchers in 2000 compared to previous years meant that birds were especially concentrated in the highest-quality sites – those dominated by box elder (Stoleson and Finch 2001). Again this year, the proportion of nests in box elder was exceptionally high, even though all of the Bennett birds were in young stands of cottonwood/willow.

Willow Flycatcher diet in the Cliff-Gila Valley. – We found that in the Cliff-Gila Valley, NM, flying Hymenoptera (non-ants) were the most abundant and widespread taxon throughout our samples, making up almost half of the identifiable prey items. True bugs (Hemiptera), beetles (Coleoptera), and true flies (Diptera) also ranked high in total numbers and in frequency of occurrence in flycatcher diet. Aquatic arthropods were not well represented in our fecal samples: only 2% Odonata (damselflies, dragonflies) compared to the 7% found in mixed riparian of samples of Arizona and Colorado (Drost et al. 1998). Cliff-Gila samples also lacked lepidopteran larvae, Trichoptera, Ephemeroptera, and non-insects such as spiders (Araneae) and pill bugs (Isopoda).

Comparison of Willow Flycatcher diet among breeding sites. – The diet of Willow Flycatchers varied among the four breeding sites. Several taxa predominated in the diet at all sites (Hymenoptera, Hemiptera, Diptera, Coleoptera). The Hymenoptera constituted a much larger proportion of the diet in Gila birds than elsewhere. Although such a result might occur if the Gila was less diverse than the other sites, this seems unlikely. The riparian vegetation on the Gila is relatively speciose compared to the other sites (Sogge and Marshall 2000), and thus likely to support a more diverse assemblage of prey taxa. In particular, the Roosevelt Lake sites are dominated by exotic salt cedar, which may support lower arthropod diversity and density (DeLay et al. 1999). One notable exception is the leafhoppers (Homoptera:Cicadellidae), which are relatively abundant and diverse in saltcedar, and were significantly more prominent in the diet at Roosevelt Lake (Drost et al. 1998, 2001). Overall the Gila diet resembled that on the Kern in the relatively higher use of Dipterans and Coleopterans, but was more like the Salt River in low use of Odonates. Gila birds apparently did not prey on Isopterans (termites) or Araneaens (spiders); this may reflect the fact that flycatchers on the Gila tend to be high up in the subcanopy as opposed to in the understory as in other sites.

Are Southwestern Willow Flycatchers generalist foragers? – Every arthropod sampling method has inherent biases as to which types of prey it samples well (Cooper and Whitmore 1990, Poulin and Lefebvre 1997). Sticky traps primarily sample flying insects, and tend to sample only poorly such non-volant groups as lepidopteran larvae and mites (Cooper and Whitmore 1990). However, as Willow Flycatchers are primarily aerial foragers (Sedgwick 2000), we feel it is reasonable to assume that the arthropods sampled by sticky traps were representative of those taxa most available to flycatchers foraging within the study site.

We found significant differences between the relative abundance of arthropods within the Cliff-Gila Valley sampling sites and their relative abundance in the fecal samples, whether we included thrips in analyses or not. The Hymenoptera made up over 47% of the prey items, but constituted less than 10% of the arthropods caught on sticky traps (19% without thrips). Similarly, Hemipterans made up 17% of the diet, but constituted less than 1% of the available prey (2% without thrips). In contrast, 14-20% of sticky trap arthropods were Dipterans (45% excluding thrips), yet accounted for only 10% of the diet.

Thus, it appears that Willow Flycatchers on the Gila do not take arthropod prey in proportion to their availability. This suggests that the flycatcher should not be considered a generalist insectivore. Rather, it appears that flycatchers may be preying selectively on Hymenoptera and Hemiptera at this site. For example, the high use of Hymenoptera we found is not simply because bees and wasps are particularly abundant and visible – no butterflies or moths were represented in fecal samples, although they are a much more conspicuous component of the diurnal aerial arthropod fauna (pers. obs.). It is noteworthy that aquatic arthropods made up only a very small fraction of the flycatcher diet, suggesting that the flycatcher's strict association with water is *not* food-based.

The suggestion that flycatchers are not generalists is supported by the observation that the diet on the Gila was more similar to that recorded at other sites in the Southwest, including the very different Roosevelt Lake sites that are dominated by non-native saltcedar, than to the general arthropod community on the Gila. It seems likely that saltcedar habitats support a very different, and probably less diverse, arthropod community than does the mixed native riparian habitat on the Gila, as has been reported from saltcedar habitats on the Rio Grande in New Mexico (DeLay et al. 1999). Similarities in diet among sites are unlikely to be due to similarities in arthropod communities, but more likely due to similar prey selectivity among flycatchers at those sites.

It should be noted that our assessment of availability may better reflect what arthropods are present at the site rather than what is actually available to foraging flycatchers (Wolda 1990). It is unclear whether those taxa under-represented in the diet (e.g., thrips) might be less available to flycatchers than suggested by trap data because of behavioral or life history traits. For example, nocturnally active insects would be well sampled by sticky traps but may be only rarely found by diurnal flycatchers. Alternatively, certain prey types may be unpalatable and therefore taken only infrequently. Further research needs to be conducted on potential factors such as these that might skew our comparisons.

Does prey availability determine Willow Flycatcher density? – We found no significant differences in the proportions of arthropod orders among the three Gila sampling sites (Table 4). Further, although the absolute numbers of arthropods collected varied among sites, that pattern of variation did not correspond to flycatcher numbers. The site with the fewest arthropods (NW1) supported moderate numbers of flycatchers, while the site with intermediate levels of arthropods (NW2) had none. Also, the abundance of Hymenoptera, the most frequent prey taxon in the Cliff-Gila Valley, was inversely related to flycatcher density – the site with high numbers of flycatchers (SE1) had the lowest counts of Hymenoptera. These results argue that food availability *per se* is not responsible for the observed variation in flycatcher numbers among sites in the Cliff-Gila Valley.

Conservation and management implications. – Southwestern Willow Flycatchers take a wide variety of arthropod prey. Although dominated by flying insects, they also take terrestrial forms (wingless ants in this study; termites, mites, and spiders in the Arizona and Kern studies). Although flycatchers are strongly associated with water, invertebrates with aquatic stages make up only a minor component of their diet.

Despite the apparent diversity of prey items taken by the Cliff-Gila population, our results suggest the birds may not be true generalists, but rather seem to be selective in their prey choice. Their high use of relatively mobile bees and wasps suggests they may be vulnerable to accumulation of pesticides from prey that range into agricultural areas adjacent to riparian zones (Paxton et al. 1997).

Prior descriptive studies of flycatcher diet suggested flycatchers might not be limited by food, based on the diversity of prey items identified (Drost et al. 1999, 2001). We found no evidence that flycatchers in the Cliff-Gila Valley were limited by food in 1999. However, we believe that if flycatchers are indeed specializing on certain prey taxa, they could be vulnerable to stochastic or deterministic declines in the abundance of those taxa, especially in less healthy riparian ecosystems. We strongly encourage additional research on flycatcher diet to assess both prey use and availability. This research should be conducted at multiple sites, including both native and exotic dominated areas.

Future Project Goals

In 2002, we hope to expand our characterization of Willow Flycatcher habitat at large spatial scales (landscape, watershed) in collaboration with Katherine Brodhead, now of Montana State

University, to enable a greater understanding of the distribution of flycatchers in the region. And, as in previous years, we will conduct official flycatcher surveys in collaboration with Dennis Parker, and find and monitor flycatcher nests.

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APPENDIX. Population estimates of Willow Flycatchers by patch in the Cliff-Gila Valley, New Mexico, based on protocol surveys. Numbers are: pairs (+ probable single territorial males).

PATCH	Survey 1 (5/22 - 5/24)	Survey 2 (6/12 - 6/16)	Survey 3 (7/8 – 7/11)
NW1	2 (+4)	3 (+4)	4 (+1)
NW2	0	1	1
NW3	0 (+2)	3	1
NW4	6 (+4)	10 (+1)	11
Bennett project	3	6	5
NW5	0	1 (+1)	0
NW Stringer	0 (+1)	1	2
NE1	0	1 (+1)	1
NE2	0	0	0
NE3	1	1	0
NE4	4	3 (+2)	3
NE5	3 (+1)	6 (+1)	5
SW1	2 (+2)	4	3
SW2	3 (+3)	4 (+4)	7
SW3	4	4 (+1)	4
SW4	1 (+2)	4	3
SW5	0	0	0
SW Crescent	0 (+1)	0	0
SW Stringer	3 (+3)	16 (+1)	10
SE1	6 (+11)	16 (+4)	12 (+1)
SE2	10 (+4)	11 (+1)	8
SE3	2	3 (+1)	1
SE4	3	6	5
SUBTOTAL U Bar	53 (+48) = 101 terr.	104 (+22) = 126 terr.	86 (+2) = 88 terr.
Fort West Ditch	0	2 (+1)	3 (+1)
Gila Bird Area	1	2 (+1)	3 (+1)
TOTAL	54 (+48) = 102 terr.	108 (+24) = 132 terr.	92 (+4) = 96 terr.